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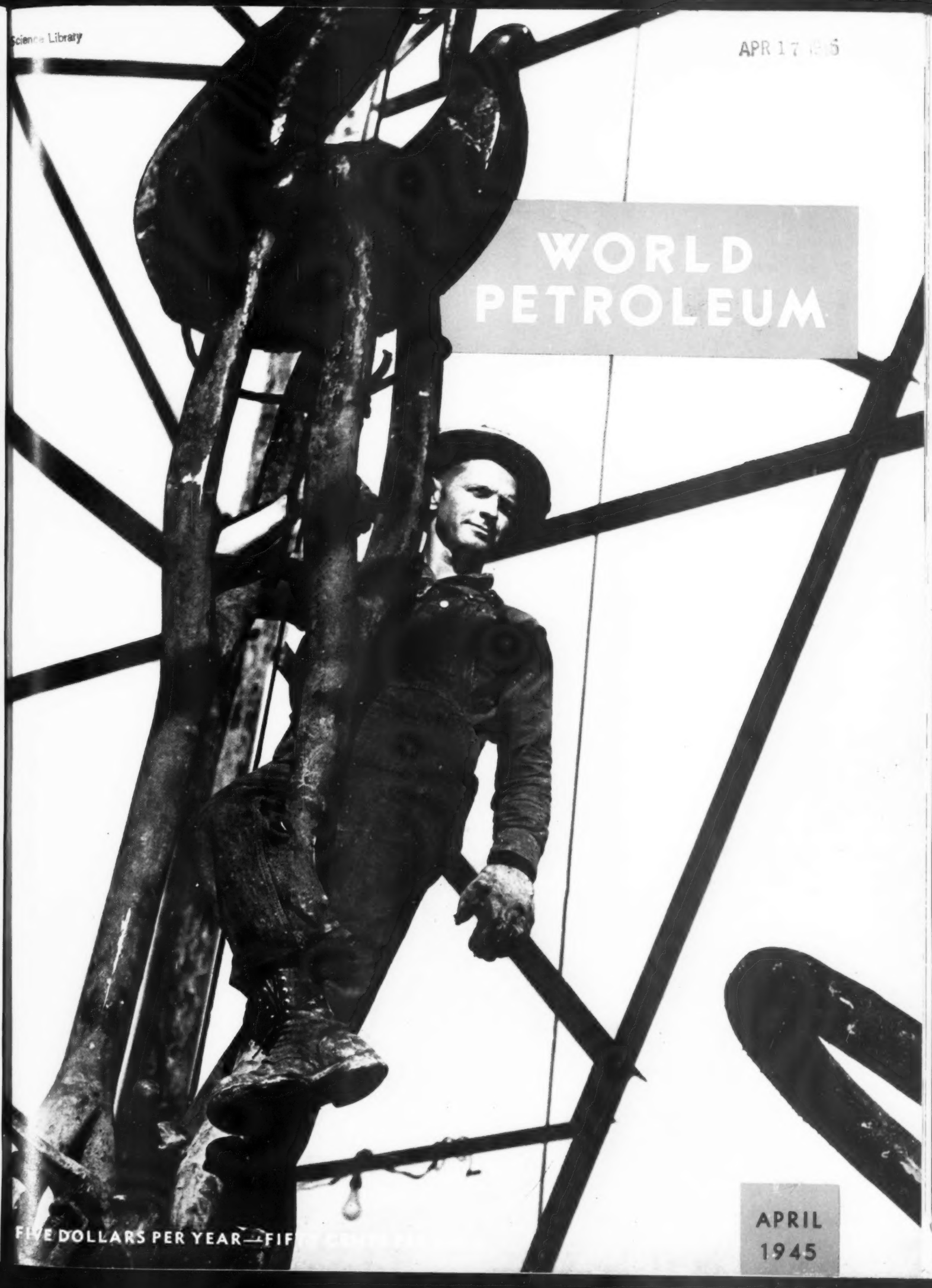

WORLD PETROLEUM

FIVE DOLLARS PER YEAR—FIF[illegible]

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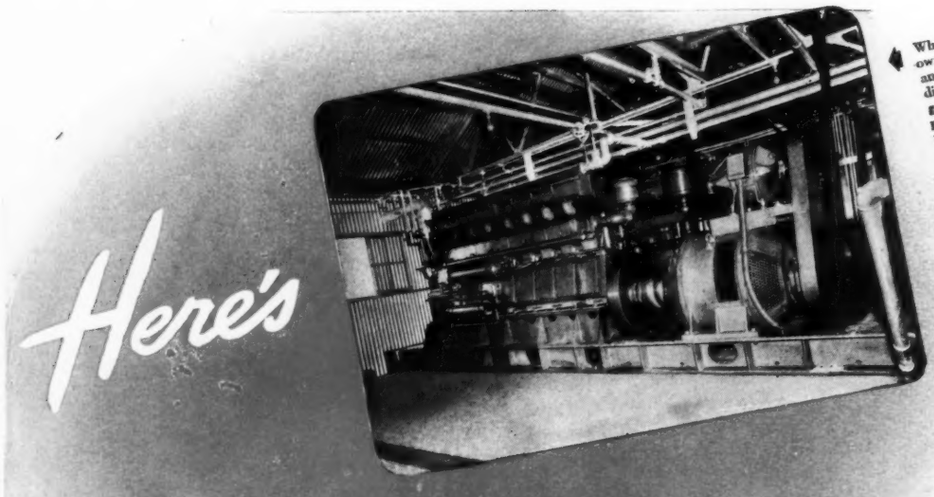

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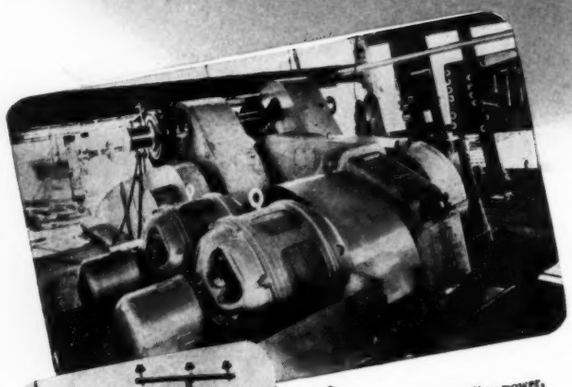
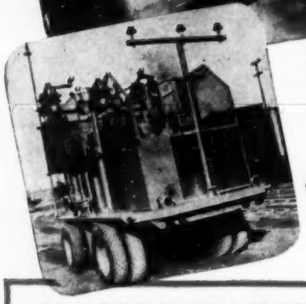


When you're near high line power, here's a compact a-c power package —twin variable speed 125 hp motors —one for drilling, both for hoisting.



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WORLD PETROLEUM

Founded by Russell Palmer

PUBLISHED BY MONA PALMER

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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CONTENTS

Post War Trade Policy	35
U. S. Bombers Did a Job at Ploesti	37
Military Geology Aids Conduct of War	42
Shell Studies Jet Propulsion	45
California Plays Vital Part in Pacific War	46
New Plants Provide "Cushion of Safety"	49
Source Beds and the Search for Oil	50
Results of Exploration in Colombia	52
Neches Attains 150% of Designed Capacity	54
Washington Notes	56
U. S. Reserves Gain in 1944	58
Well Completions in 1944	60
Oil Company Staff Changes	61
Petroleum Abstracts	70

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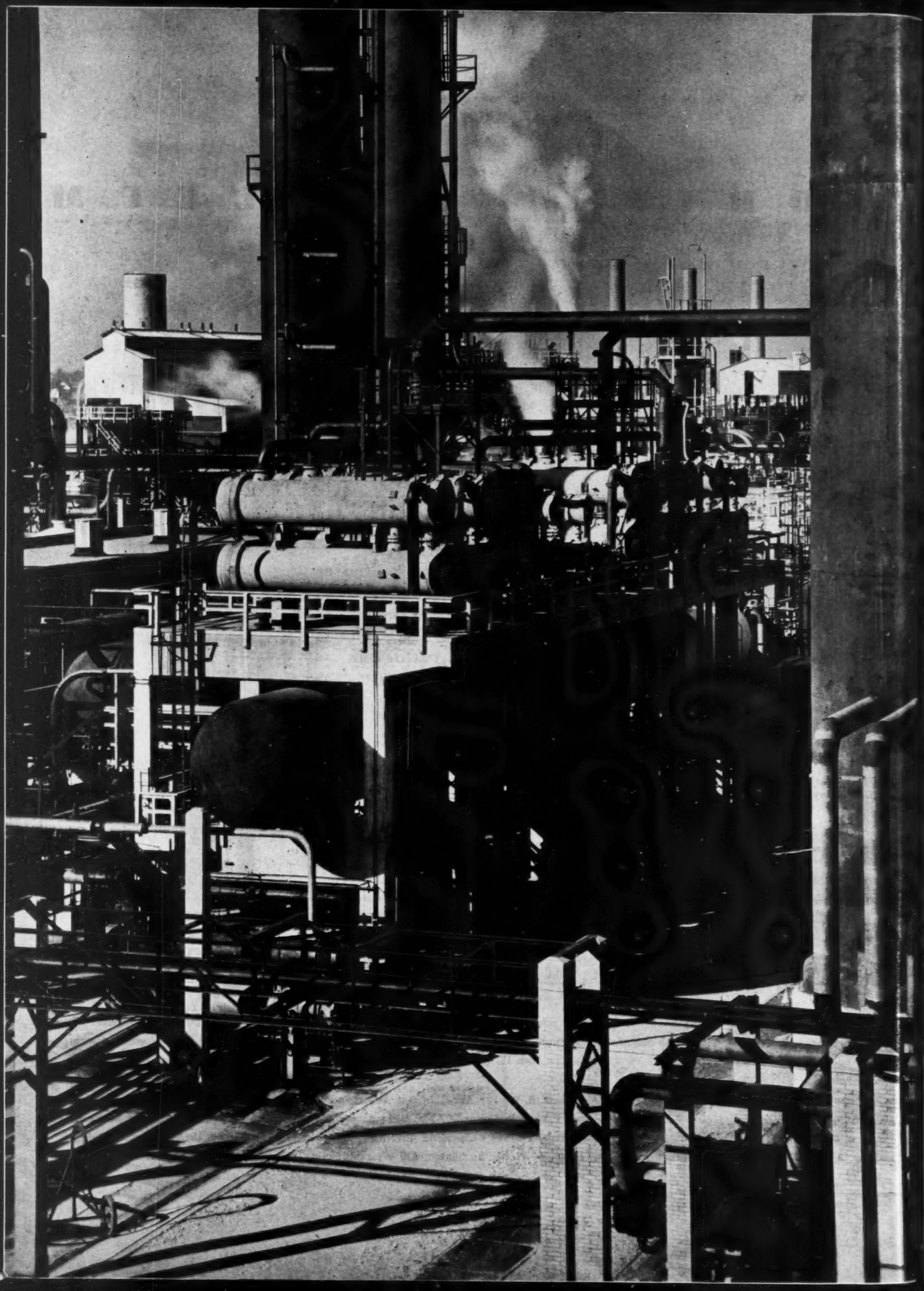


EDITORIAL

POST WAR TRADE POLICY NEEDS CLARIFICATION

UNDER pressure of public opinion at home and insistent urgings from abroad the government of the United States is moving somewhat tardily toward the definition of its policy on collective action to assure the security of the post war world. By joining in the declaration of Chapultepec it took a long step, in company with the other American republics, toward the establishment of an acceptable basis for maintaining peace in the Western Hemisphere. The approaching conference at San Francisco is expected to evolve concrete plans for a world wide agreement. What is still lacking, however—and it is of utmost importance that it should be decided without delay—is the economic policy which this country is to adopt or which at least it will support in the many conferences which will take place in the course of the effort to build a system of world trade that will conduce to peace.

Certain broad generalizations have been uttered by the President and by other leading members of the federal administration—freedom of access to markets, equitable distribution of products, removal of trade barriers, protection of the rights of individuals —yet in the specific application of such principles the course of government representatives has been halting, uncertain and in some cases inconsistent. The main trouble seems to be the lack of clear thinking as to what is necessary in order to translate these theoretical aspirations into the realities of a practicable working system among a large group of nations whose interests and ideas are far from uniform.

As has become clear from the meetings and the exchanges of ideas among the titular heads of the leading Allied nations, no one government can expect to have its position accepted on all points. The decisions of any league that may be established, by whatever name it may be called, necessarily must be a series of reconciliations of diverse views and claims. This will apply not only in the political sphere but in the economic field as well. And these compromises must be accepted by all members of the world organization if the league is to function successfully.

If the United States is to join in the world organization that is now in process of formulation—and sentiment in favor of its participation seems now to be well in the ascendant—it will be one member, an influential member it is true, of a group comprising perhaps threescore nations. It may propose but it cannot dispose and when decisions are reached it must accommodate itself to them even though they may not represent the ideals to which America traditionally has been devoted. In the field of trade even more than in the field of politics the decisions of a world economic conference are likely to result in substantial changes in our methods of handling international commerce and such changes are bound to be reflected in our domestic business organization because it is obviously impracticable, despite the views of some of our heavy thinkers in official positions, to maintain one system for internal use and to follow an exactly contrary one in external affairs.

We like to think of ourselves as the outstanding exponents of the competitive system, the advocates of free enterprise and open competition. We are opposed to cartels; every pronouncement from official Washington reiterates this antagonism. Yet every move made by the federal government in the past decade in relation to trade and industry has been in the direction of cartelization and every conference thus far held in relation to regulation of world commerce has resulted in proposals for the establishment of what are in effect international cartels. So evident has this trend become that the Washington formula has been modified to hold that cartels are right and praiseworthy when run by governments but are anathema only when conducted by private interests. Yet official agreements to control distribution and apportion markets, because they are more sweeping in their application, can be even more blighting than private understandings, in their effect upon individual initiative and enterprise.

In considering the feasibility of a world organization to bring about a fairer apportionment of international trade it must be remembered that other nations do not share the prevalent American feeling against cartels operated by their own nationals or by international groups. Before the outbreak of the present war more than 150 such organizations were in existence and in many of these the foreign trade departments of American companies were represented. In fact, participation in an established cartel was essential if a company wished to do business in certain countries. It is a reasonable certainty, therefore, that if the United States is to take part in an organization

Exchangers at Neches Butadiene Plant.

for the equitable regulation of world trade it will have to be on the basis of cartelized control of many kinds of commodities.

Officials of the federal departments have issued repeated warnings that if reasonably full employment is to be maintained after the war a great increase in the export trade of the United States will be necessary. Estimates of $10,000,000,000 a year in sales to other countries, about double the highest previous peacetime record and three times the annual rate just previous to the war, have been mentioned as a minimum requirement. To enable other nations to buy from us on such a scale we are told, reasonably enough, that we must vastly enlarge our imports and open our markets to the admission of foreign goods through the reduction or removal of tariff duties. This means that highly organized groups of foreign producers or traders, with the covert or active support of their respective governments, will be able to make a strong bid for business within the United States. It is cheerfully assumed that this will have no effect upon our own production for the domestic market and that we can continue our system of legal prohibition against any form of agreement or consultation among American producers without placing them at a disadvantage in either the home or export fields. A number of the State Department publicly declared only a few weeks ago that "what other countries do does not make it necessary for our firms to join cartels. In fact, we have a better chance of expanding our exports if we stay outside the cartel system".

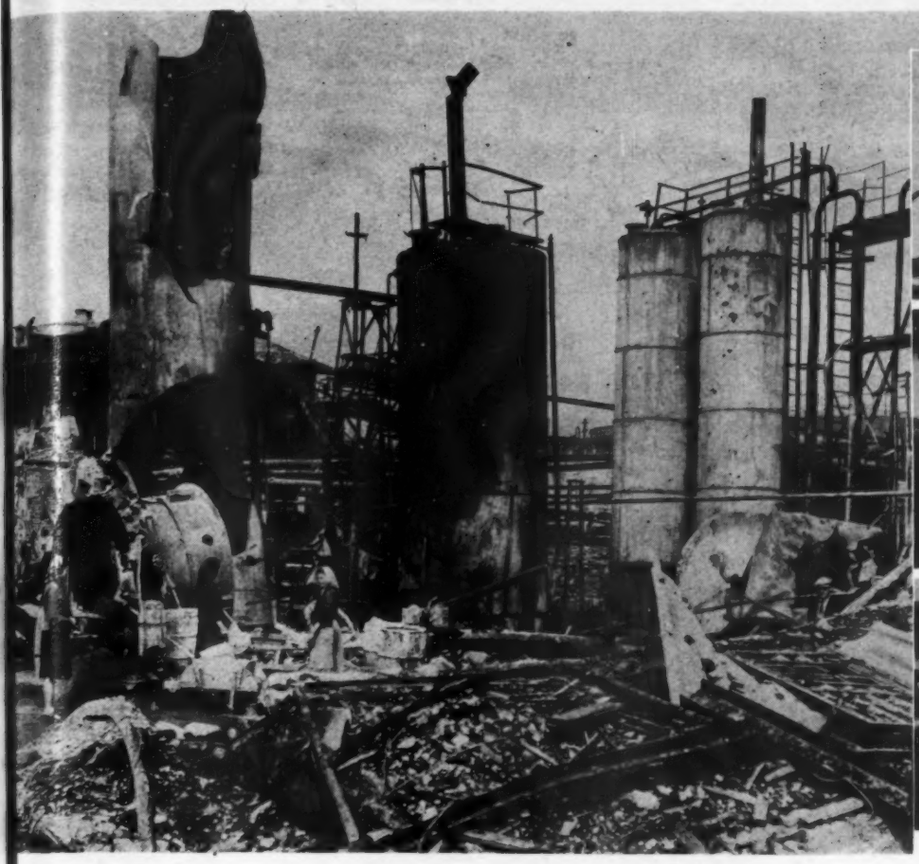
A more realistic view of the prospective situation is taken by the well known "liberal", Milo Perkins, who assuredly cannot be accused of being a tool of Wall Street or a supporter of monopolies. Writing from a detached viewpoint in a recent magazine article he recognizes frankly that the business men of many foreign nations will conduct their post-war international business through cartels and will have the support of their governments in so doing ."This fact," he says, "not only will affect every American who does business abroad but will deeply influence the domestic economy of the United States."

It should be obvious that in commercial intercourse government operated or government backed organizations will hold a decided advantage over individual enterprises that are denied the privilege of concerted action. As Mr. Perkins observes in this connection, "American business, even at its strongest, is relatively helpless against the competition of well-organized foreign business supported by the power of their governments." His proposal is not that American firms be forbidden to join international trade agreements but that such arrangements be registered with the State Department and through annual reports be subjected to public scrutiny.

American business does not ask for governmental support or assistance. A fair field and no favors is the platform on which it has made its way around the world. It is committed to the competitive system under which it has built up the most powerful industrial machine the world ever has seen. But if business is to become the subject of international treaty, and if markets are to be opened to organized invasion, American industrialists have the right to use the same methods and the same weapons that their competitors will be armed with. Thus far nobody in administration circles or in Congress has voiced a demand for such equality of treatment. On the contrary the eager prosecutors of the Department of Justice are waiting with unconcealed impatience for the time when the gravity of the war emergency will begin to lessen so that they may press action against the members of the oil industry for maintaining an organization that has nothing whatever to do with marketing operations but has as its primary objectives the advancement of technical knowledge, the adoption of uniform standards and the promotion of safety in its operations.

In the proposed revision of the Anglo-American oil agreement drawn up by the National Oil Policy Committee of the Petroleum Industry War Council the one clause that is reported to have caused most embarrassment to the Department of State is a three-line statement referring to reports of the projected international petroleum commission which says that upon the publication of any such report by a government "any action taken in compliance therewith shall not be deemed an infringement of its laws with reference to restraints of trade." This simple assurance that observance of recommendations made by a body established through action by the government of the United States shall not be made the excuse for civil or criminal prosecution by that government has reputedly led to grave headshakings in official circles and much questioning as to the propriety of its inclusion in the agreement. It may be that a treaty is not the proper place for such a protective clause since it is inconceivable that any other government would contemplate such action but the past experience of American oil men and the present attitude toward their industry on the part of at least one powerful federal agency makes it necessary that some such safeguarding clause be officially and unequivocally promulgated in connection with the establishment of an international oil commission with other than purely advisory functions.

If an economic parliament of the world, built along lines such as are envisioned in some official circles, is to be established there must be provided not only equality of access to markets but also equality of methods and instruments used in seeking and promoting trade. If the United States can persuade all the other governments associated in such a movement to prohibit participation in trade agreements and combinations and to adopt a system of enforced and unlimited competition then American business will not hesitate to enter the lists with confidence that it can hold its own. If on the other hand the organizations and combinations that have long been an established feature of European and other international trade are to continue in operation then the United States should change its existing legislation to allow its own industrialists a like opportunity to act together and to present a united front in maintaining their position in markets which are admittedly of vital importance to continuing employment and future prosperity within its borders.



Left: Wreck of Treating Plant at Steaua Romana.

Above: Section of Captured German Film Showing Efforts to Extinguish Fires.

U. S. BOMBERS DID A JOB AT PLOESTI

By Jesse L. Walden *First Lt. Air Corps, U. S. A.*

WHAT may well be counted as one of the decisive campaigns of the European war was that waged by American bombing planes against the refining center of Ploesti, Romania, heart of the Nazi system of petroleum war supply. Beginning with the dramatic raid of August 1, 1943, and resumed intensively in April, 1944, the air assault was continued during the following months until refinery production was reduced to a mere tenth of its earlier volume when Soviet troops took possession in August of that year.

This article, with the accompanying illustrations, officially approved for publication by the Bureau of Public Relations of the U. S. War Department, reveals in detail the extent of the damage inflicted upon these important installations and the elaborate nature of enemy defenses. It demonstrates that the best protected plants can be destroyed from the air but only by persistently repeated attacks. The lessons learned at Ploesti are being applied against Hitler's steadily shrinking oil resources and are gradually reducing to impotence the once irrestible war machine that overran almost the whole continent of Europe.

ON November 2, 1944, the biggest air battle of the war took place over Germany, when half of more than 1,100 Eighth Air Force heavy bombers, escorted by 900 fighters, attacked the giant Leuna synthetic oil refinery at Merseberg. For the first time in many weeks, the Luftwaffe, which had remained in hiding while Allied bombers laid waste to whole cities, rose to defend the target. The fierce resistance and reckless abandon with which its carefully husbanded fighters were expended—208 Nazi planes shot down—testified to the desperation of the Reich with regard to its gasoline situation.

It is more than a figure of speech, therefore, to say that the picture of a badly mauled Germany, driven behind the defensive bastions of its homeland, is a portrait in oil. Fuel and lubricants—the lifeblood of any war machine—have been systematically drained from its veins. Blow by blow, the sledgehammers of strategic bombing have pounded away, until Hitler's oil production of more than a million and a quarter metric tons a month has dwindled to a thin, sluggish trickle.

Germany's oil position is traditionally unsound. Production and refining capacity of crude, even in peace, has never met the domestic consumption, the deficit having been made up by imports and synthetics. The synthetics, which produced close to half of Germany's total liquid fuel, are largely concentrated in eight mammoth installations, located at Merseberg, Politz, Brux, Lutzkendorf, Zeitz, Bohlen, Magdeberg and Ruhland.

By far the larger percentage of Germany's natural petroleum sources were scattered through Axis controlled Europe. The great Ploesti refining district in Romania with its 19 square miles of densely crowded pumping, cracking, distillation and power plants was able to furnish greater Germany with 28 percent of its fuel demands, and, more important, with a third of all Nazi gasoline.

It is not easy for Americans, who have long been used to an oil abundance, to understand the importance of this small area to the Wehrmacht. Perhaps it will be easier to visualize the vital necessity of Ploesti if the reader will envisage the loss to the United States of one half of the oil produced in Arkansas, Colorado, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, New Mexico, New York, Ohio, Oklahoma, Pennsylvania and Wyoming. Should this catastrophe happen to us, the proportionate blow would be no greater than that actually suffered by the Germans when they lost Ploesti.

The facet of the campaign which destroyed 90 percent of the Ploesti capacity, before it fell to Allied armies, is worth considering in some detail. It is not only interesting because Ploesti was the greatest single source of Nazi oil, but

In the Heart of Ploesti, Showing Devastated Area Occupied by Several Large Refineries.

also because complete and accurate evaluation has been made possible. The production figures in this article, including monthly pre-attack capacities, are from official Romanian records and have been verified by a special AAF Evaluation Board set up for this purpose.

Before going into details of the attacks and the results accomplished, however, it is interesting to review the Ploesti of August 1943. Eleven great refineries, rated as capable of putting through 757,000 metric tons of crude a month, are located in a 19 square mile area. The largest of these units was the British and Dutch Shell owned, Astra Romana, which served as a central receiving station for oil from most of the other plants, and pumped it to the Giurgiu terminal of the pipeline on the Danube, over which it was transported to the Reich. Astra's equipment included gas-liquefying and cracking machinery for high test gasoline. Also included were 334 tanks with a storage capacity of 420,000 tons.

Astra Romana almost surrounds the smaller Phoenix Orion, also British owned, and regarded as a particularly vulnerable target because of the concentration of its equipment. It included a lubricating oil plant, one of the few in Romania. Total production of Astra and Phoenix was 211,000 tons a month. The first bombing attack did heavy damage to both, but they were soon producing more than before because of the standby repair facilities and highly trained repair crews. Phoenix was utterly destroyed in May 1944 and Astra's production fell to zero.

Steaua Romana is the second largest refinery in the district. It is owned by British-French interests and is located 15 miles northwest of Ploesti in the heart of the oilfields. It is well equipped, has extensive cracking facilities, two modern distillation plants, a McKee unit and a Stratford Unit with a potential output of 125,000 tons a month. The August 1943 raid completely knocked out Steaua for a period of four months. It slowly recovered despite repeated bombings, but all attempts to continue production were discontinued after Aug. 10, 1944.

Next in size is Concordia Vega, originally owned by the Belgians before being taken over by German interests. Its extensive distilling and cracking facilities are modern and it was capable of producing 110,000 tons a month. It was hard hit in May 1944, but continued to produce on a limited scale until the coup de grace was delivered on August 10

Fourth largest in the region is Romana Americana, owned by Standard of New Jersey. This plant was not bombed on the first raid in August 1943 and thereafter many sought its shelter during succeeding raids in the belief that the Americans would not harm what was theirs. Their hopes were shattered in May and June when the plant fell heir to a series of blasts which cut production from 109,000 tons in August 1943 to a mere trickle of 12,000 tons in August 1944.

Incidentally, restoration of all legal rights and interests of American owned corporations is provided for in Article 13 of the Armistice agreement. Certificates of protection, furnishing protection against expropriation by Russians and Romanians, have been issued to Standard and 15 other American owned or controlled corporations operating in Romania. Russia assented to this procedure.

Although Creditul Minier is one of the smaller Ploesti plants, its equipment is the most up-to-date. It has the only iso-octane plant in Romania, plus a sizable Dubbs cracking unit. It produced 45,000 tons a month before the August 1943 attack. All facilities were so completely wrecked that the plant never operated again.

Another 45,000 ton producer was Columbia Aquila. Its modern equipment included a sizable Winkler-Koch cracking plant. The whole plant was flattened on the first raid in August 1943 and all production was suspended until the following July, when it began producing in limited quantities only.

Standard Petrol and Unirea Sperantza are two of the smaller refineries with a productive capacity of 69,000 tons. At the time of the first attack, Standard Petrol was inactive, but was immediately pressed into service and operated successfully until April 1944 when successive bombing seriously damaged it. Unirea was a standby plant for the Phoenix and when the Phoenix was severely crippled, the Unirea was

operated at full capacity until it too folded and never opened again.

Another of the smaller plants is the Xenia. Its total area encompassed 39 acres. However, its capacity output was only 22,000 tons a month. When compared to the larger and more modern refineries, it was old-fashioned and poorly equipped. It had no cracking facilities and its only important installation was a distilling unit. Ignored in the early attacks, it sprang into production and was soon operating at capacity in order to handle the increasing flow of crude which could not be put through the damaged refineries. As repairs were made on the more important installations, production at Xenia dwindled until it was stopped altogether in March 1944. When the raids began again in April, production was resumed, and the plant was still operating when the Russians took over, despite one serious bombing in July.

Least of the important Ploesti refineries is Dacia Romana. Its equipment is old and inefficient, but does contain a distillation unit and a small benzine plant. It was dormant at the beginning of the campaign. However, it received less damage than any of the other plants and was soon pushed to its capacity of 15,000 tons a month. At the beginning, its capacity was only 1.3 percent of the Ploesti total, but by the end of the campaign this percentage had been increased to over six percent.

There are four other small refineries in the Ploesti area—the Lumina, Noris, Cometa and Redeventza. These were relatively so unimportant to be unattractive targets and were seldom bombed. Their production was so small that they were stripped of most of their equipment, which was utilized to repair damage in the larger refineries.

The original plan to destroy the huge concentration of vital fuel production was conceived by General Arnold and his staff. Weeks of planning was necessary; then more weeks of preparation and training before the 117 B-24's participating took off on the now historic raid of August 1, 1943. This first attack was a continuation of a rehearsal which had begun six weeks before at advanced bases in North Africa.

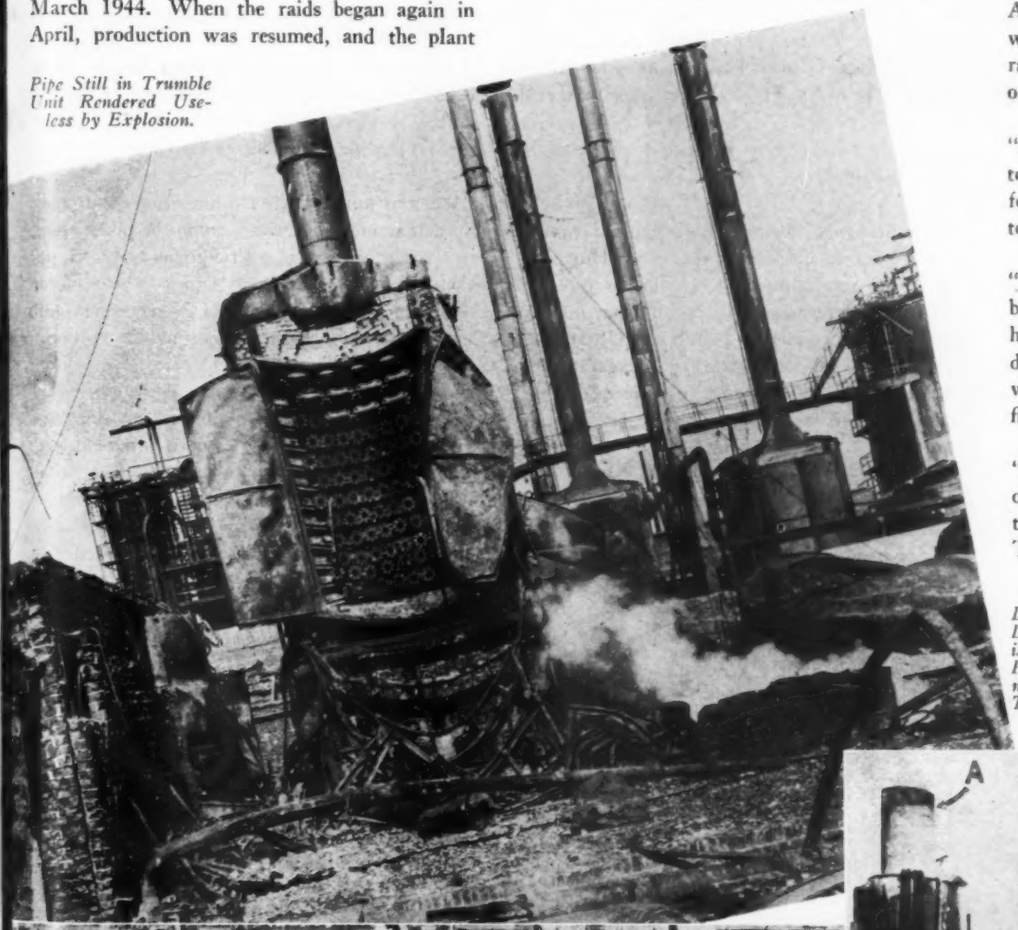
A graphic description of this low-level raid was given by Capt. John S. Young, one of the raiding pilots, in AIR FORCE, the official organ of the Army Air Forces.

"About 35 minutes from our target, we lowered to twenty feet off the ground. And I mean twenty feet. We were coming in so low, our plane had to pull up to keep from hitting a house.

"About two miles from the target, the flak guns bellowed out a reception comparable to none I had seen in 330 combat hours against heavily defended targets. Most of it was 20mm stuff, with some 40mm and a lot of machine guns. The fire was plenty accurate.

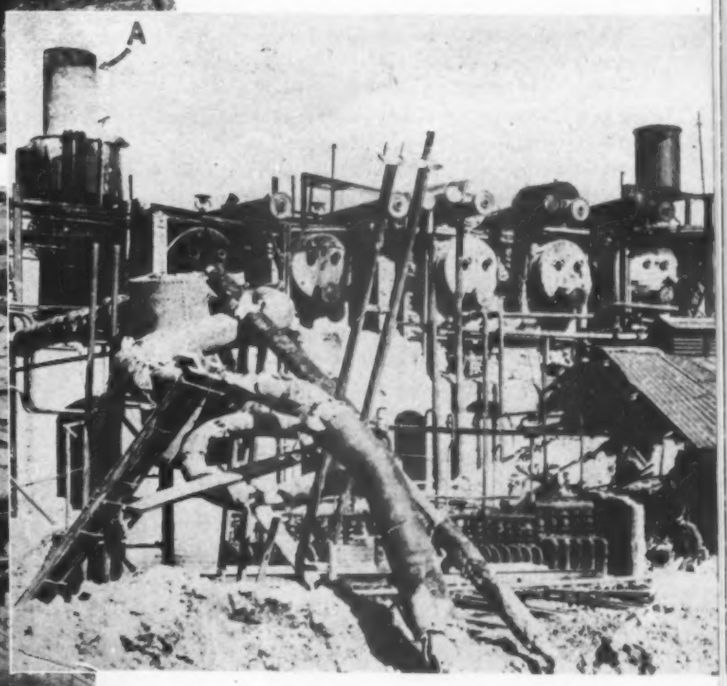
"A mile and a half from the refineries, we opened up with our fifties, aiming at the oil tanks which held about 55,000 gallons of oil. They started to explode, throwing smoke and

Pipe Still in Trumble Unit Rendered Useless by Explosion.



Lower Left: Although Little Evidence of Damage is Shown, Due to Repairs, Production at Astra Romana Was Down Two-Thirds When Photograph Was Made.

Below: Ground View of Standard Petrol Showing Stills Wrecked by Bomb Blast.



flames about 500 feet into the air. There we were, buzzing at twenty feet, doing 200 miles per hour, flying through intensive flak and bouncing around between oil fires. Play that on your harmonica sometime.

"Our particular targets were the Orion and Astra Romana refineries. They had smoke stacks about 210 feet high, so we had to climb to about 250 feet to drop our bombs. Flames were biting in through the bomb bay doors, the heavy smoke fires made visibility difficult and the flak fire was beating a hellish tattoo all over our ship, but with all the practice under our belt we had no difficulty picking out our targets. We laid our bombs down the middle."

The havoc wrought by this opening salvo was tremendous, considering that only 142 tons of bombs were dropped. Despite the loss of 54 planes, Astra Romana's powerhouse was put out of operation and its cracking installation was demolished, as well as half of the remaining functioning capacity. Creditul Minier, Columbia Aquila and Steaua Romana—three of Ploesti's most modern plants—were hard hit. Half of the Phoenix Orion refinery was obliterated and the Lumina works had a large portion of its vital parts reduced to rubble.

Before the raid, Ploesti was theoretically capable of producing 757,000 metric tons of crude a month. However, only 458,000 tons were actually being put through, of which 177,000 represented maximum gasoline production. This was partly due to the fact that Germany was getting sufficient oil, partly due to the fact that production from the Ploesti fields was gradually subsiding. Production for the next month dropped to 269,000 metric tons. Repairs were rushed and in another month production was up to 431,000 tons. However, two of the active refineries in the region were so badly damaged that they never resumed operation again.

For the next eight months Ploesti was not disturbed. Neutralization of the Luftwaffe was the order of the day. Thousands of German planes were destroyed on the ground and in the air. Communication lines, great marshalling yards, aircraft factories and related industries were scientifically demolished. In addition, this terrific campaign was paced by week-in, week-out demolition of depots, storage tanks, railway tank cars and other supplies.

In April 1944 the 15th Air Force began to soften up the target by pounding the marshalling yards to the north and south of the fields themselves—this time flying at 20,000 feet with fighter escort.

Beginning in May the bombers concentrated on the refineries. Three large scale raids were staged. The Steaua Romana was definitely put out of commission and the overall production had been cut down to 317,000 tons monthly.

June brought three more stabs, including a low-level attack by P-38's of the 15th AF which left one crude oil distillery plant and ten oil storage tanks in flames.

The giant Astra Romana plant was severely rocked in the five pummelings delivered in July. Grave damage was also inflicted upon the Romana Americana and the Concordia refineries, as well as the storage facilities at the Unirea.

Four times in August the Ploesti plants were saturated with bombs before the Soviet Army walked in on August 19 to take over the 10 percent that was left. At this time only five of the original refineries were operating at all.

Ploesti was never a soft touch and the defenses became greater with the passage of time. In addition to fighter planes, the flak defenses were the densest over flown against by Allied airmen; 250 heavy and 400 light guns protected an area of 19 square miles. Over 2,000 smoke tanks could completely black out the area in twenty minutes.

A few statistics, for military security reasons, must remain unpublished at this time. However, analysis of the following scoreboard is interesting in that it reveals a glimpse of what may be expected when conditions permit the USAAF to fully utilize all-out air armadas against the mammoth synthetic plants in Germany, or against the oil areas now owned or held by Japan.

Number of raids	26
Number of effective sorties	5,479
Tons of bombs dropped	13,700
Oil loss to enemy, in tons	1,334,000
Tons of oil for one ton of bombs	97.5
Reduction of oil producing capacity	90%
Enemy aircraft destroyed	334
Probably destroyed or damaged	239

Allied Army leaders and industrial experts know well the vital points of Axis production and refining. Despite adverse weather conditions, air assaults are constant and effective. Weather permitting, mighty armadas strike at the huge synthetic plants, and total Nazi production declines steadily and inexorably.

To soften the effects of air raids, the enemy has been surrounding his targets with extremely strong batteries of heavy guns, including 88's, 105's and even 128mm railway guns. At Brux, for example, photo reconnaisance shows that about 200 guns guard the area, an increase of 116 since July. Politz is guarded by more heavy guns than are used to protect entire cities—Bremen, Hanover, Frankfort or Munich. In addition, extravagant pains have been taken to insure a supply of spare refinery parts close by and preference is given to refinery labor and material, even over armament manufacture.

Nevertheless, eloquent testimony to the leak which air power has punched in the German gas tank is evidenced in a withdrawal order, captured from the 26th Panzer Division:

"Armored units which are not completely ready for action and those which cannot be taken along on account of the fuel position must be blown up. Commanders will have to decide which motor transport will be taken along and which left behind, basing their decision on the fuel position."

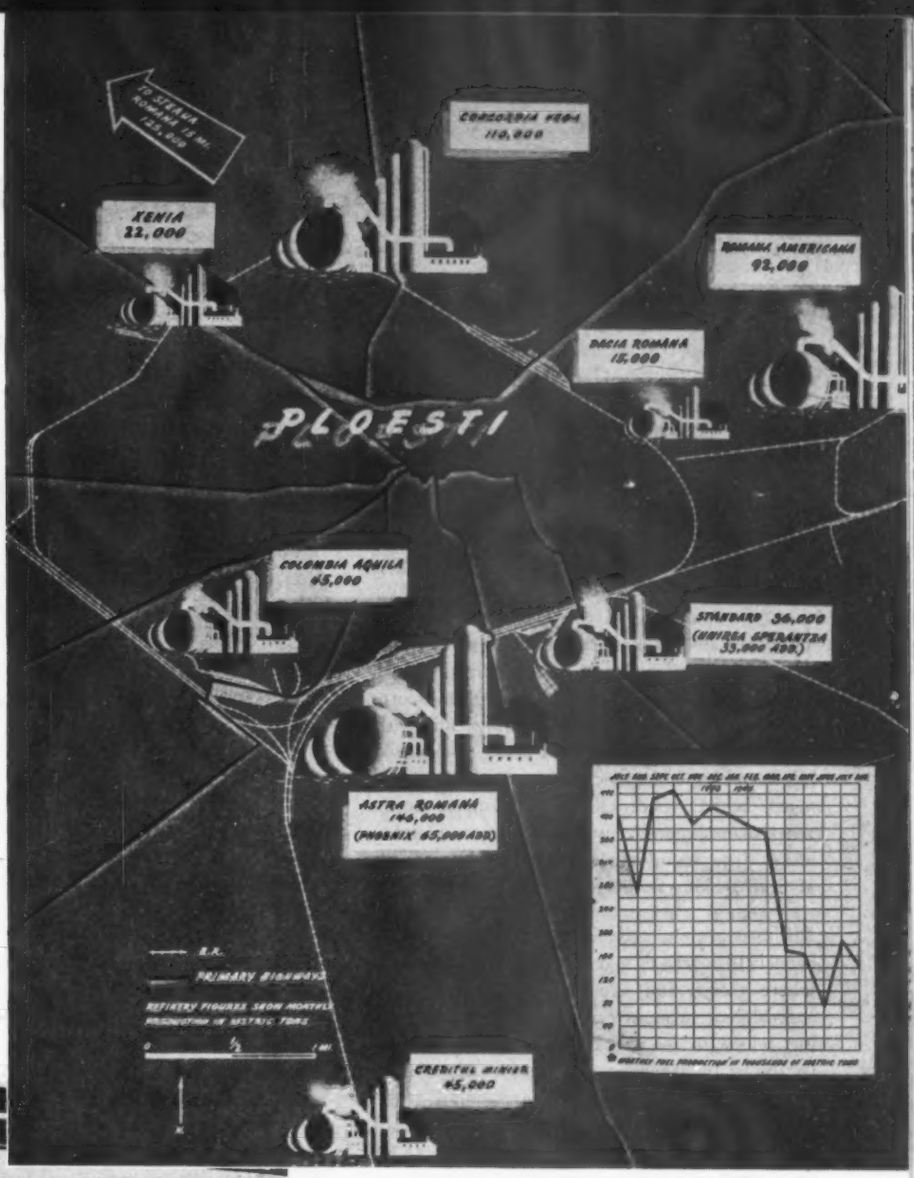
Outward evidences of a serious pinch are everywhere. Commanders of motorized divisions are required to submit daily reports of fuel consumption and have been ordered to use horse drawn vehicles wherever possible. The German Air Force training program has been drastically cut. Civilian use of gas and oil is practically unknown.

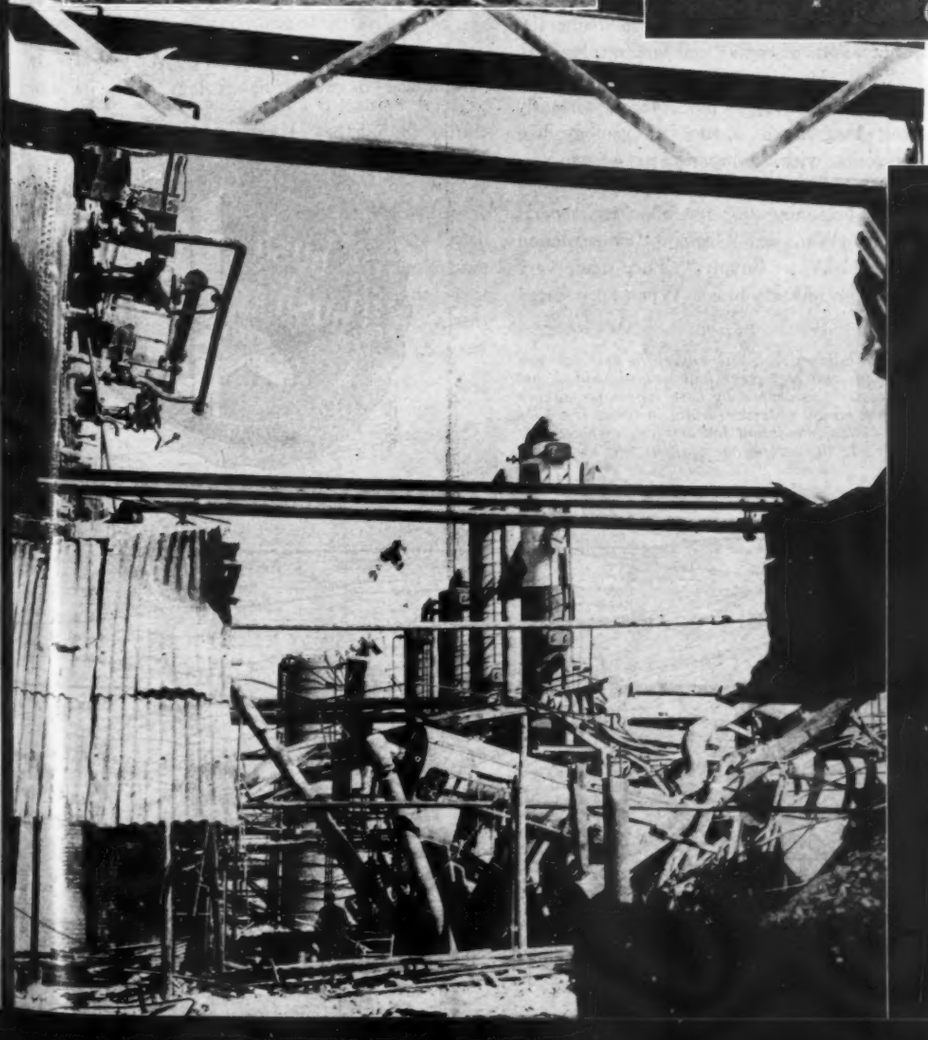
Obviously, the enemy is desperate. The bombardment of his oil industry has been and continues to be his worst headache. And when the wheels of the Wehrmacht grate and grind to their last stop, Germany's defeat may well be ascribed to too many troubled waters—and not enough oil.

Blast Wall Built to Protect Tank at Astra Romana Failed to Protect.

Below: Distillation Tower at Romana Americana Temporarily Replaced After Being Knocked Down.

Right: Photo Map to Guide Pilots — Chart Shows Bombing's Effect on Production.





Left: Debris of Concordia Refinery; Fractionating Towers in Background.

Below: Consolidated B-24 Bombing Astra Romana.

Military Geology Has Rendered Vital Service in Conduct of War

By Ruth Sheldon

WARNING placards in certain Washington offices depict a Sherlock Holmes character peering around a door, finger to lip, saying "hush-hush. Confidential!" Encircling him is the announcement "Section of Military Geology U. S. Geological Survey". The finger has come down from the lip enough now to reveal the story of a vital war service—the application of geology to modern warfare.

Long one of the most secretively guarded projects under the direction of the Strategic Intelligence Branch of the Army Engineers Corps, military geology has been aiding alike the Marine landing on Iwo Jima beach, the bomber pilot carrying out a special mission, the espionage agent behind enemy lines in Europe, the infantryman digging a foxhole, the commanding officer drawing up battle orders, the Joint Chiefs of Staff making strategic plans.

Military geology tells us before we get on the battlefield where to make artillery emplacements, where troops and supplies will find the best concealment, what streams are suitable for fording, where troops will have the greatest maneuverability in attacking the enemy, where tanks can go, where we can find water supplies, where we can build roads, where we can place military fortifications and airfields, what equipment we shall need and what construction materials we can find on the spot. It is telling us what enemy strategic resources are most inviting bomb targets. It warns where enemy concealed airfields and troop concentrations may be. A folio of military geologic maps of a battle area is the answer to the $64 question.

As will also be seen, the development of military geology during this war has given birth

Charles B. Hunt

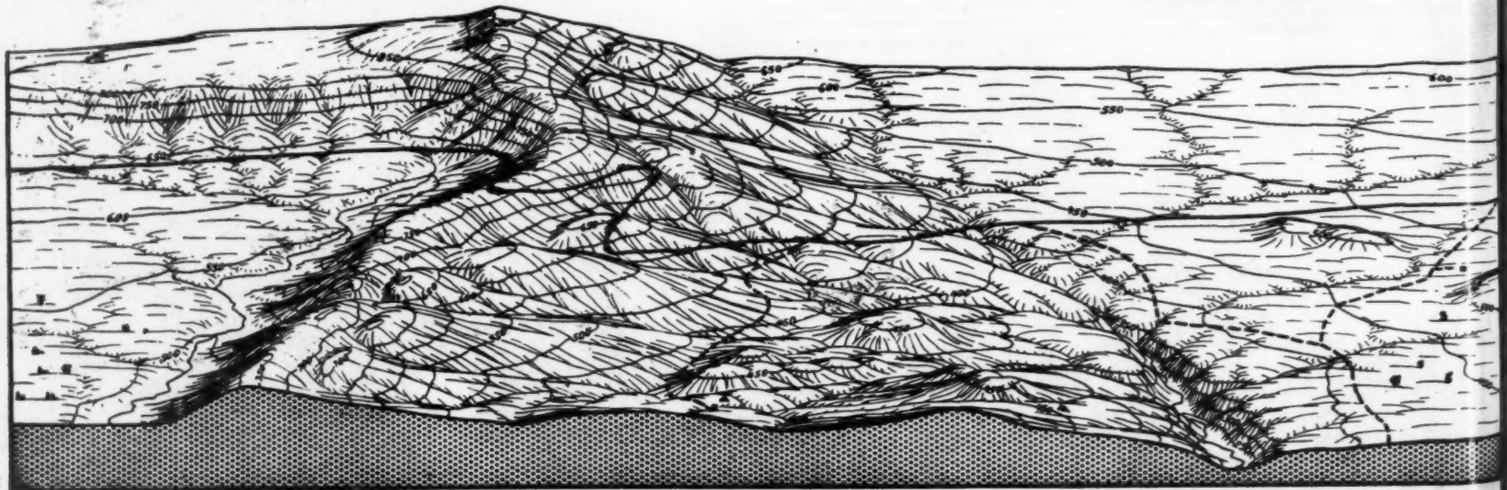
to an entirely new field of engineering geology which will prove of invaluable postwar aid to the petroleum industry and others. Although geology has come out of its ivory tower to aid the fighting man it had to change its name in order to be permitted to don khaki. It now travels in army circles as "terrain intelligence". In the very reason for changing its name lies the explanation of what military geology is. Some Army tactical officers instinctively shied away from the thought that the mysteriously technical, long-haired science of geology had any connection with the practical art of warfare. In the spring of 1942 when the Military Geology Unit was beginning to function, its reports were referred to as "Geology, Construction Material and Water Supply." They made very small dents on military brass. When an inspired Army Colonel changed the label to "terrain intelligence" the product became immediately marketable and has since been in constant demand.

"Terrain" is where geology meets military and marriage ensues. A war is fought over, on and for terrain; consequently knowledge of the terrain is all important to the military. Terrain is a neutral offering the same features to us and the enemy, but it can be made a powerful ally by superior application of superior knowledge. Geology can provide that superior knowledge to such a degree that it could well be called the Dunninger of military science.

The art of militarizing geology is simply translating its wealth of technical and scientific knowledge of terrain into military terminology so that it becomes a military tool. For example, all ground in a certain area looks alike to a soldier digging a foxhole. But a military geologist preparing a map of the area before the battle knows that certain parts are kaolinitic clay shale while others are micaceous silt ground. He points out on his map that a foxhole dug in kaolinitic clay shale would become a regular cistern when wet, whereas foxholes in micaceous silt ground would be better drained and not so likely to collect water.

The United States Geological Survey was already organized to militarize geology with its vast

Fig. 1 (below) shows topographic features only while Fig. 2 (on opposite page) shows same terrain with geologic information added. For example a continuous depression east of the ridge fails to appear on the topographic map but is clearly indicated on the geologic map by the position of the contact between the hard standstone D and the softer sandy shale of C. Two rounded hills on the south side of the map between the main ridge and east creek look alike in Fig. 1, but the more easterly is capped by hard limestone making it impossible for an observer to dig in while it would provide a better foundation for artillery emplacement than would the second one with its soft shale.



accumulation of foreign source material and its highly competent staff of trained personnel familiar with foreign geology to the extent that it operates without translators, as the staff members have a reading knowledge of many foreign languages. The geologists were eager to prove to the Army what they could do. Lt. Col. J. E. McCaffery, of the Corps of Engineers Intelligence Division godfathered this infant military science and sold the Army on the capabilities of his prodigy.

The resulting Military Geology Unit is a unique example of a civilian group working under army supervision. The actual military geological work is done by a group in the United States Geological Survey headed by C. B. Hunt. His staff numbers one hundred, of whom 75 percent are professionals—geologists, soil scientists and other specialists. They receive assignments from the Intelligence Division of the Corps of Engineers and compile terrain intelligence folios on strategic areas. These consist of a series of maps and explanatory tables each stressing a special engineering topic. Together the maps and tables cover such subjects as terrain appreciation, rivers, water supply, problems of road and airfield construction and availability of construction materials, fuels and mineral resources. These folios are printed by the Army and rushed by special air courier to the war theater.

At first the Intelligence Division had to introduce the folios just as though they were sponsoring a new breakfast food. But when the general staff saw that the unit could live up to the staff's highest expectations of it, and when the various branches realized that these reports weren't fresh out of a crystal ball, but could aid them almost as much as any other form of intelligence, the Military Geology Unit settled back to fulfilling request orders which poured in. Col. McCaffery turned over his job to able Maj. A. R. Spillers, who is assisted by a civilian geologist, M. Connaughton. Now Col. McCaffery is in the Philippines—a customer for the product he launched; and the Strategic Intelligence Branch is among the most widely consulted of the Army's various intelligence staffs.

Not only is the Military Geology Unit in Washington accurately advising our fighting men what to expect in battlefields thousands of miles away, but teams of civilian geologists are also in the war theaters advising in more detail on the spot. Five men are in the Southwest Pacific, six in the Central Pacific with five others on the way and more requested. Two are in England coordinating plans with the British military geologists and three are in the European theater of operations.

So valuable are the services of these men in the field that the data they prepare play an important part in drawing up battle orders. In the Leyte invasion three military geologists accompanied the troops on D-day, serving as consultants on the ground.

Army Engineers use geologic intelligence folios as a tactical commander uses a map, not as a substitute for reconnaissance but as a way of narrowing down the area—before we actually occupy it—where on the spot reconnaissance will be needed. Time is never so important as it is to the task force engineer who must find construction materials and construction sites at the most readily available places, and plan his construction projects before he can make an on-the-site survey.

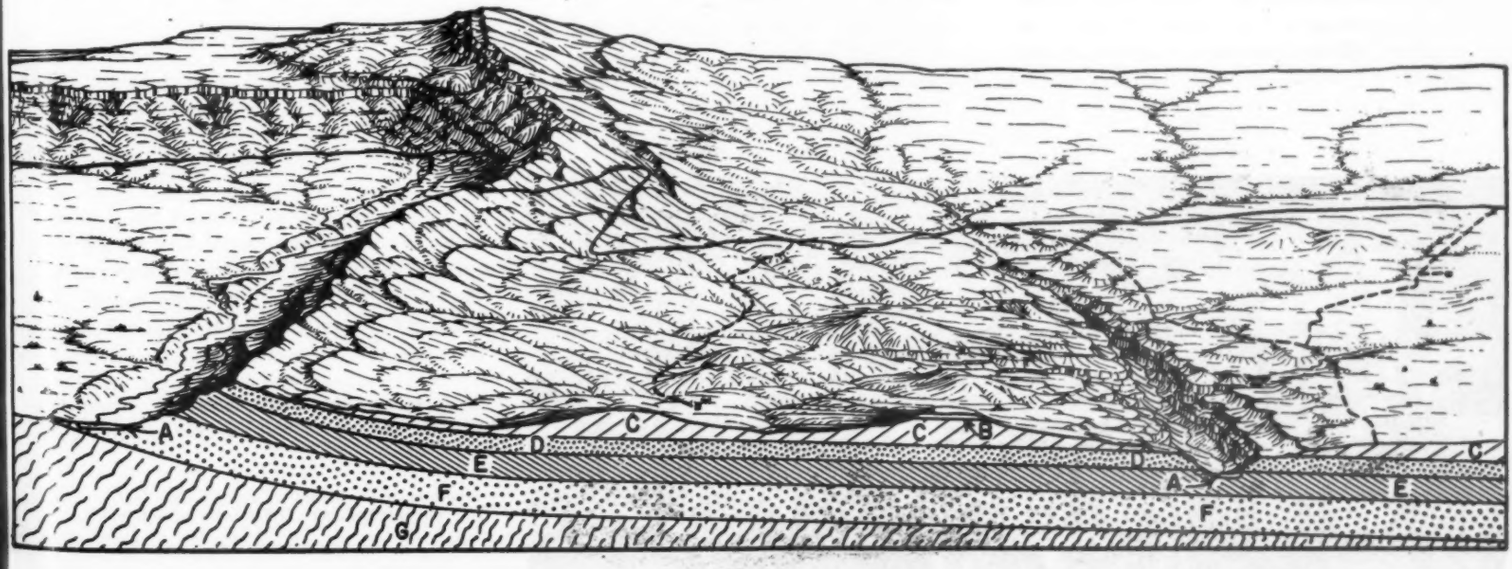
Prior to an invasion of one of the Pacific islands, General Hugh Casey was perturbed in planning construction of an airstrip following the island's capture. He needed coral as a construction material and wasn't sure just how long it would take him to find it. The military geologist spoke up, "General, when you land you will find coral right on the island under three feet of overburden." He pointed out the area on the map. The General wanted to know if this was guess-work, for he had to be sure. Time was essential on this important airstrip. If the materials weren't there they had to be provided, not brought in later. The military geologist assured the General he would stake his reputation on the coral's existence. When the landing was made and a bulldozer swung into action, the coral showed up at exactly three feet depth.

Again, in the southwest Pacific the tactical staff had picked a site for an island airstrip which typographically appeared perfect. The military geologist assured them that, although the soil appeared ideal, when the rains came in two or three weeks it would be covered with three feet of water. He recommended an area on the other side of the mountain. The site had the disadvantage of being wooded but when the landing was made the bulldozers easily cleared away scrub woods and a fine all weather airstrip was constructed while the area first contemplated lay inundated with water.

Although the most spectacular military jobs have been done in connection with locating airstrips, the Unit has performed minor miracles in assuring the Army and Navy of proper water supplies wherever they have gone. They have been able to perfect a technique of carefully withdrawing a layer of underground fresh water that rests on sea water under the islands. They have shown the Army engineers where to obtain proper road construction materials; a deposit of suitable material may be lying just a few feet away vertically and would be ignored if the military geologic detective didn't point it out. The savings in time and labor and consequently in life have been tremendous.

The Unit's "trafficability" maps have played a vital part in guiding battle campaigns successfully through unfamiliar territory—showing safe and usable routes of penetration into enemy areas. The military geologists in Washington work under their own battle conditions on occasion. A cable recently arrived frantically demanding "trafficability" maps needed immediately. The demand seemed impossible but

The geologic map shows that for trafficability, the eastern part of the area would be bad in wet weather due to shale formations. However, it is more suitable in dry weather than the hilly belt and flat ground to the west. As a natural foundation for roads, runways or other construction the flat ground to the west is the least suitable in the area because the soil is compressible, lacks stability, is subject to severe frost heave and could not be readily stabilized even with borrowed aggregate.



Mr. Hunt calmly sent his Unit into action with all members working 32 hours without stopping. As many as four worked on a map at the same time. They were an exhausted but triumphant group for the maps arrived in time to meet the urgent need. The esprit de corps which Mr. Hunt and his staff have developed is deserving of tribute.

The members of the Unit are particularly proud of their contribution to the Sicilian campaign. On May 9 they received cabled orders to prepare a full report on Eastern Sicily to be delivered in North Africa by June 1. On May 20 the Unit had completed 47 maps, two terrain diagrams, 36 large tables of text and 39 photographic views. These were given to the Army Map Service for printing and arrived in North Africa by special air courier on the afternoon of June 1. These reports received special commendation from General Davidson, in charge of Sicilian engineer operations, who found them not only accurate and complete, but at times indispensable and in many cases possessing more information than the natives themselves. General Eisenhower's headquarters immediately cabled for similar reports on the Italian mainland.

The Unit receives requests for aid from all branches of the service. At the request of the Air Forces its members made a study of critical mineral resources in enemy controlled territory to aid in selecting bomb targets of vulnerable bottlenecks in the enemy's procurement of vital materials. They have made a special study of the engineering problems posed by permanently frozen ground. One officer, who planned to land by "puddle-jumper" plane in the remote parts of certain interior mountains, was assisted in selecting a landing place along the beach of a small mountain lake. Other officers operating behind enemy lines were given preliminary reports on site construction problems in order to expedite ground observations.

Although its accomplishments have been remarkable, military geology is far from new and in some respects our enemies have developed its use to a much higher degree. Military geology was actually employed first as such by the Russians in the Russo-Japanese war in 1906 when they sought geologic advice in preparing heavy foundations of permanent fortifications. Russian army engineer officers later were required to take courses in geology.

The Allies and Germany all organized military geology units during World War I, but the Germans made the greatest progress. By the end of 1918 the Germans were using about 250 geologists, of whom 100 were on the western front. The American Army managed to obtain authorization to assign five geologists to each Army, or one to each corps, but the Armistice was signed before the organization was complete and before much practical work was done. During the lull between the wars the Allies paid scant attention to military geology and maintained no formal organizations. The Germans, however, continued to work on the subject, publishing many papers and practical handbooks on military engineering geology and its value. The form of our present military geologic work is based upon a German handbook published in 1938.

The extent to which the Germans are using military geology in this war is evidenced by the fact that in Italy alone they had 600 geologists, whereas the total American staff for all theaters and Washington is only 100. British Military geology efforts were keenly stimulated when they captured German invasion plans of southern England and discovered that every other sentence commented, "Achtung! Consult the geologist!"

British military geologists, realizing the necessity of coordinating American and British units, sent special missions to the United States and a system of close coordination has been devised. A British leader in this field is Wing Commander Daniel C. Ion, formerly a geologist with the Anglo-Iranian Oil Company.

Information is not available as to the extent to which the Russians are using military geology; however, in one respect they have formally evidenced their appreciation of its value to a greater degree than we have. The only geologist to be decorated for geological services during this war is an American Army Major, Bennett Frank Buie, who received the Order of the Red Star from the Russians last year "for outstanding ability and professional skill in locating and developing dependable water supplies for the Russian Military Railway Service" in Persia. Buie, who is attached to the Persian Gulf Command, was formerly a geologist for the Standard Oil Company of California, working in the Middle East. Not only are petroleum geologists actively participating in military geology, but the oil companies have assisted the Unit. Standard Oil Company of New Jersey and Standard Oil Company of California have been particularly helpful in providing maps and reports from their files on areas where published information was inadequate.

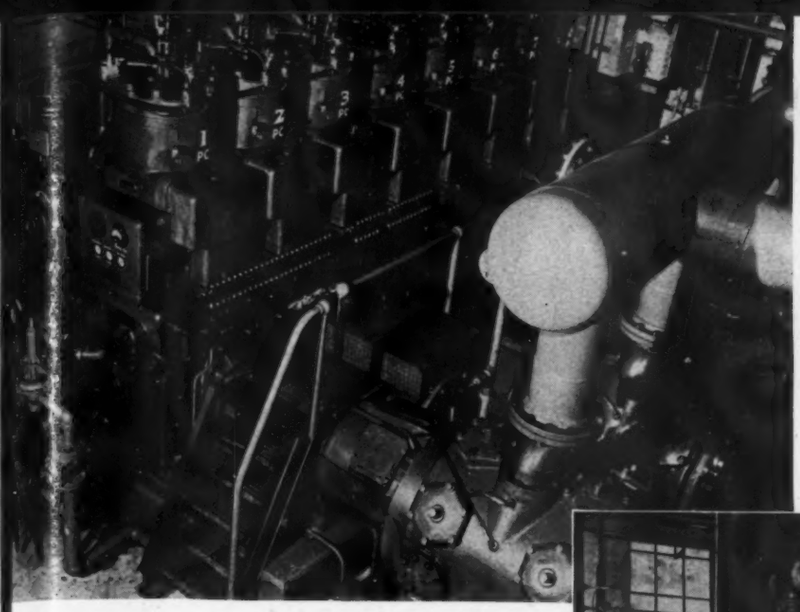
The principal source of information for making military geology reports are the geologic and typographic maps prepared by foreign geological surveys, which have been systematically collected by the United States Geological Survey for the past 60 years. Other government, private and public libraries have yielded valuable materials. The National Geographic Society was a lucrative source of pictures which have helped to interpret ground conditions in many remote areas.

The necessity of reexamining our own sources and abilities in the light of military geologic need has emphasized the fact that geologic and typographic surveys in most foreign countries have received more support than in the United States and their surveys are much more nearly complete. From available source material, without actually going into the field, it would be possible for our Military Geology Unit to prepare a more detailed report on Japan than on the state of Indiana. This is a challenge to increasing our own research and encouraging both government and private research geologists to do a thorough geological job after the war, not only in the United States but throughout the world. Accurate terrain intelligence of every square mile of the world is an important peacetime project. Its immediate use would be for peacetime economic needs, but it is a vital preparedness measure.

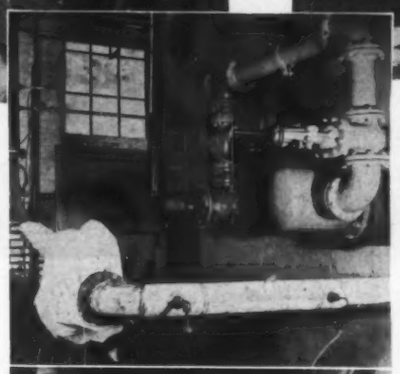
Oil company executives can well afford to examine military geological operations with a view to adapting the principles developed to commercial use. Just as the Military Geology Unit has been able from an office in Washington to advise the general staff where to place airfields, fortifications, roads, and other works in an area thousands of miles away; where to find the needed materials in the area and how much time and labor will be consumed in construction, so could a petroleum engineering geologist in an office in New York work out the location materials and water problems for a refinery in Venezuela. Application of the principle of "trafficability" maps prepared by the Military Geology Unit to construction of pipelines both at home and abroad opens new horizons. The engineering geologist can prepare estimates for wildcat operations in remote spots in South America, the Middle East, Africa, all of which involve camp construction, roads, water problems. His advance estimates of the conditions to be met and his recommendations on the solution of problems will save time, labor and money. As any oil man will agree, there is little dissimilarity between a wildcat well and a task force.

Military geology, undoubtedly, has pioneered a new field of commercial possibilities.

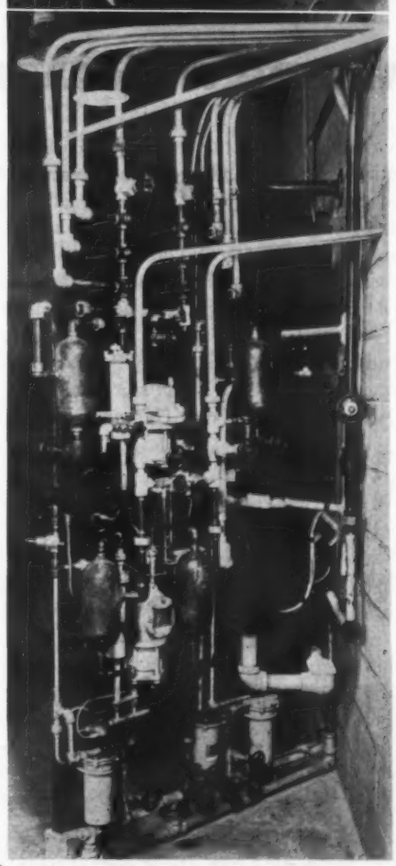
Members of the Military Geology Unit Outside the Headquarters Office in Washington.

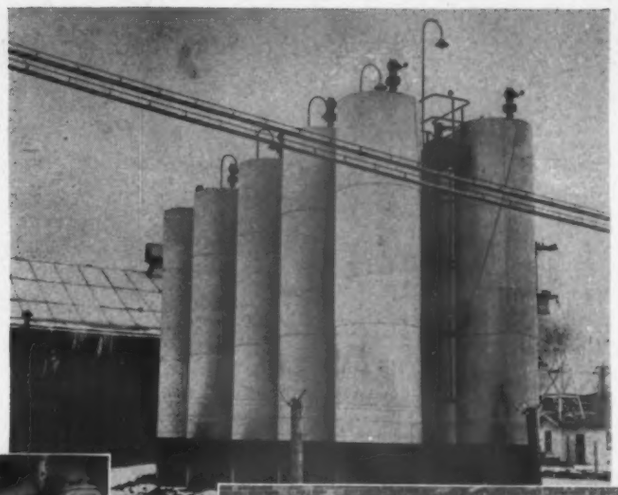


Big Compressor Fueled by Refinery Gases Supplies Compressed Air Used by the Jet-burner.



Right: Jet-burner (Concealed by Canvas) Used in Fuel Experiments.





Left: Controls for One Wing of Instrument Panel in the Control Room.

Top: Ten 5000-Gallon Tanks Store Fuel Used for Burning and Experimental Work.

Above: Milit Security Impo Secrecy on D tails of Reseai in Fuels for J propulsion.

Shell Takes Up Study of Jet-Propulsion

A laboratory for the study of fuels and lubricants for jet-propulsion aircraft has been built and put into operation by Shell Oil Company at Wood River, Ill. The laboratory, a complete, full-scale installation, was designed to study the action that fuels undergo in jet-combustion.

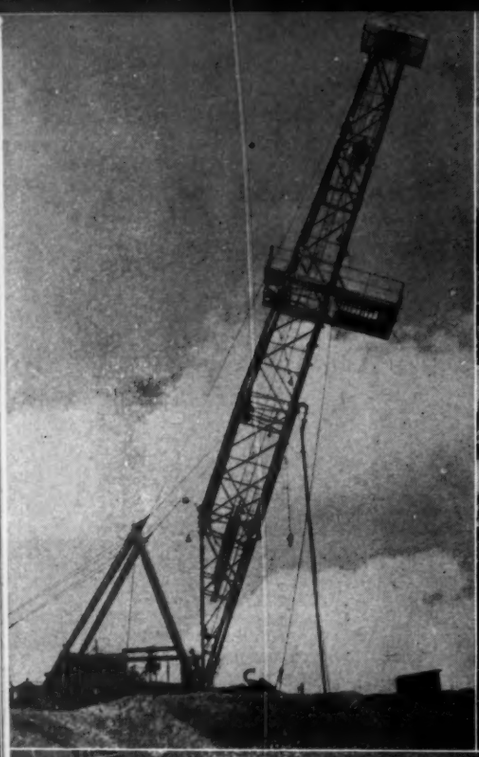
A jet burner, the size and construction of which remain a military secret, has been installed; fuel is furnished by ten 5,000-gallon tanks; and compressed air, necessary for jet-combustion, is supplied by a 1,000-horsepower Clark compressor, so large that it would require a six-room, two-story family dwelling with ceilings and walls knocked out, to house it. The jet burner produces in a much smaller amount of space about 250 times the heat of a residential oil burner and creates a stream of hot gas of greater than hurricane velocity.

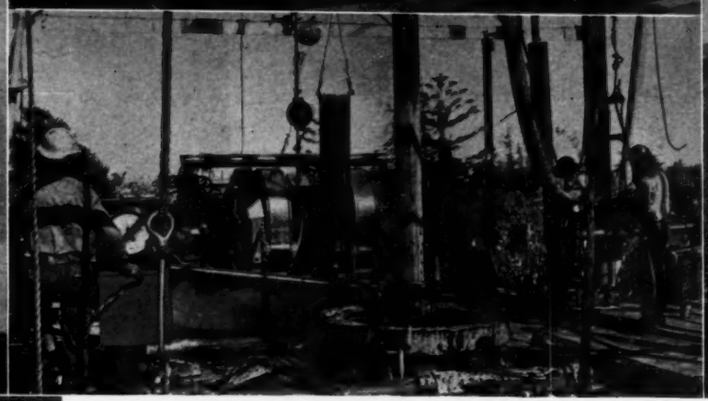
Combustion of such a radically new character requires new basic research, and completely new studies of burnings characteristics of possible fuels have been undertaken. By means of elaborate electrical recording devices located in a sound-proofed control room, the laboratory is compiling performance records on fuels suitable for use in jet-propulsion and combustion turbine engines.

In addition to surveying fuel requirements, and determining characteristics and qualities of fuels most efficient for jet-combustion, the laboratory is also at work developing new experimental apparatus for further use in this type of research.

The combustion turbine (also called the gas turbine), an important component part of the jet-propulsion engine, appears to have great possibilities as a new type of prime mover which, Shell engineers feel, may eventually compete favorably with the steam turbine and Diesel engine in locomotives, ships, and power houses. In aircraft other than military craft they believe that the best application of jet-propulsion will be in combination with a combustion turbine-driven propeller. Dream of engine designers for over a generation, the combustion turbine has only recently become a reality through developments in metallurgy which made possible turbine blades able to withstand extremely high temperatures, and centrifugal air compressors efficient enough to be used with the new combustion turbine.

"The new laboratory at Wood River," said J. F. M. Taylor, Shell's vice president in charge of manufacturing, "is an addition to the present fuel and product performance laboratories which were started there in 1927 and have grown rapidly ever since. The engine-testing section of the Wood River laboratories is one of the most complete of its kind, containing dozens of miniature and full-scale models of aircraft, automotive, and Diesel engines. Here fuels and lubricants are tested for performance, and some of the information thus obtained has already been directly responsible for important contributions to the technology of aviation gasoline manufacture during the past few years. Since 1942, enemy fuels, both German and Japanese, have been tested and broken down into their component parts for complete analysis."





Upper Left: Assembled Drilling Mast Being Raised.

Center Top: Central Steam Generating Plant Furnishes Power for Drilling.

Center Bottom: Drilling in Progress at Montebello.

Above: Deep Drilling With Internal Combustion Engines—Standard of California's Fillmore Community No. 2-1.

CALIFORNIA'S INTENSIFIED PRODUCTION PL

By J. R. McWilliams,

Director of Production Petroleum Administration for War.

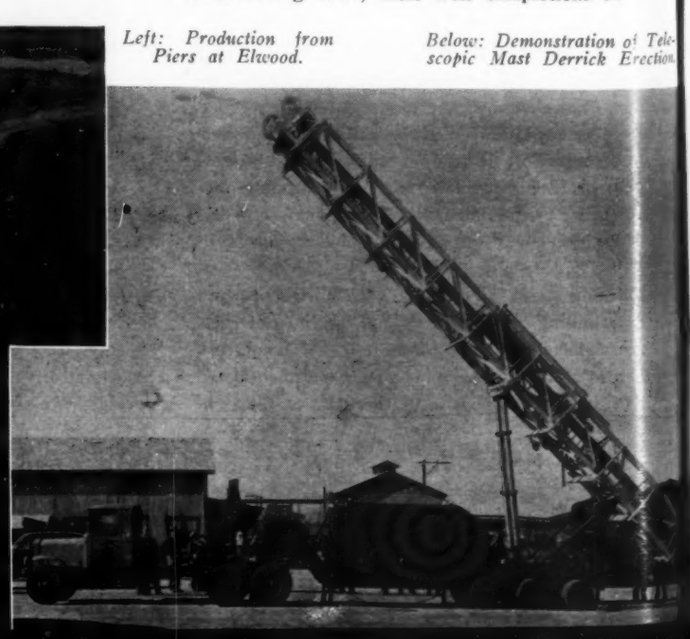
IN closer proximity to the Pacific Theater of operation than other oil producing areas under Allied control, California is being called on to supply huge quantities of oil to our military forces in that theater. The oil industry in California can be justly proud of the great contribution it is making to our ultimate victory over Japan. Considering that California has not had a major oil field discovery since 1937, its record of increasing oil production by more than 40 percent since Pearl Harbor is outstanding.

At the outbreak of the war it was thought by many that the task of increasing California production to required levels would not be difficult of accomplishment because of the substantial excess of productive capacity above requirements which was believed to exist at that time. It soon became apparent, however, that this reserve productive capacity was not as large as individual well potentials had indicated. In order to meet sharply increased production requirements, undrilled areas in proved fields had to be developed far more rapidly than was first contemplated.

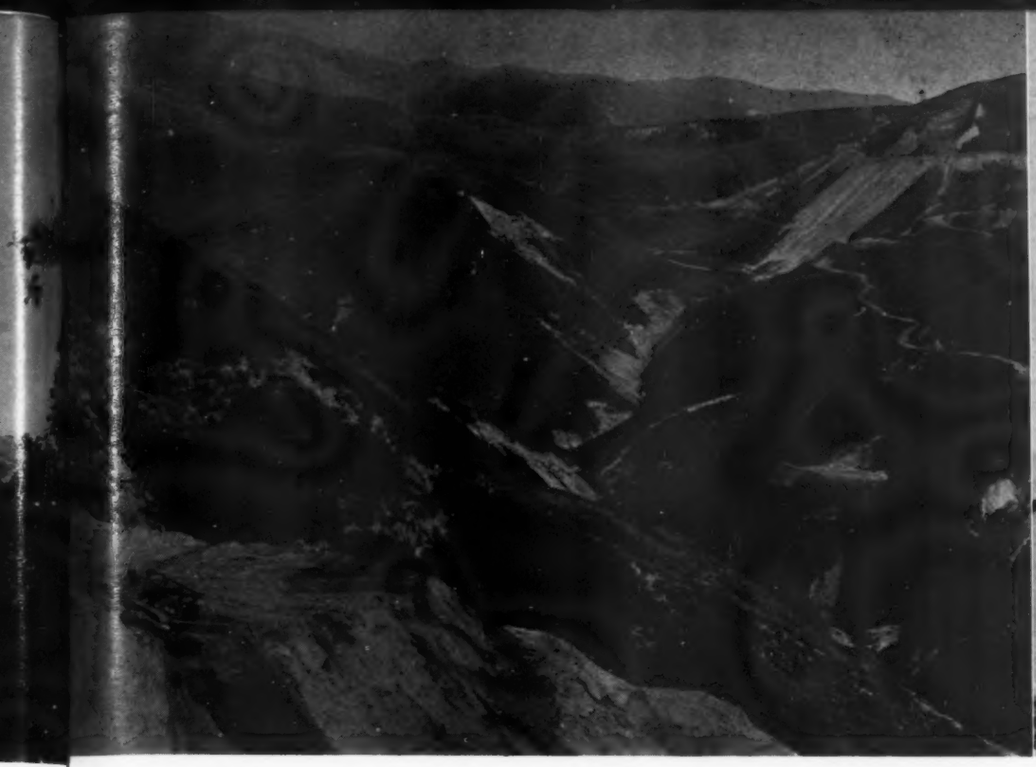
To meet the increasing requirements, a substantial drilling program was projected. That it got under way slowly was due largely to restrictions on drilling which had to be imposed nation-wide because of the scarcity of materials. Compared with average well completions of about 100 per month during 1941, total well completions in

Left: Drilling With Portable Draw-works and Mast Unit.

Left: Production from Piers at Elwood.



Below: Demonstration of Telescopic Mast Derrick Erection.



Above: Tractors are Used for Servicing Wells and Hauling in Materials.

Center: Ed and Harold Pauley's Loftus No. 1 Discovery Well at El Segundo.

Extreme Right: Drilling in Wilmington Field.

PLAYS VITAL PART IN PACIFIC WAR

Increase of 40 percent in Crude Output Since 1941 Reflects State's Fine Response to Military Needs and Establishes Highest Rate of Withdrawal in Proportion to Proven Reserves—Enlarged Exploration Activity Called for—Increased Shipments from West Texas Planned to Assure Refinery Operation at Full Capacity.

California in the first half of 1942 averaged but 63 per month. As greater allocations of steel for the oil industry were obtained, however, the completion rate rose steadily until, in the last six months of 1944, completions averaged close to 180 wells a month. Concurrently, production climbed steadily from a 1941 average of 630,000 barrels daily to a present all-time high of slightly over 900,000 barrels per day, an increase of more than 40 percent.

The heavy oil fields of the San Joaquin Valley, long known as the backbone of the California oil industry, have fully justified that reputation in this war. Drilling activity in these fields, previously dormant because of an oversupply of fuel oils in pre-Pearl Harbor years, took on renewed life with the heavy increase in demand for fuel oil by the Navy. Hundreds of existing wells have been restored to production and many new wells have been drilled in these fields. Because most of California's heavy oil fields are shallow, it was possible to use some salvaged equipment in the development, thus saving corresponding quantities of new materials for use in other areas. An added incentive toward increased development activity in the heavy oil fields was the price increase on these oils made in March 1943.

In the development of its deeper fields, the California industry has also done a magnificent job despite the unavoidable handicaps of materials and manpower shortages. Impetus to the development program, for both deep and shallow fields, was given when in the spring of 1943, PAW promulgated Supplementary Order No. 4 to PAO No. 11 which established a simple and comprehensive set of standards tailored to fit practically every important California oil field. The order provided for the automatic authorization of certain phases of California development operations, with the result that administrative detail and paper-work were limited to a minimum. Furthermore, a delegation of administrative authority was issued to the District V office in cases not covered by Supplementary Order No. 4 and for which exceptions were necessary.

As it became apparent that there would be increasing difficulty in meeting the demands for California's crude oil, Congress in mid-1944 authorized the development of additional production from the Elk Hills Naval Petroleum Reserve. A drilling program was approved under which production from the Reserve would be increased from 15,000 to 65,000 barrels a day. At present 19 strings of tools are operating in the Elk Hills field, and production has been increased to above 60,000 barrels a day. A total of about 184 wells had been completed up to March 1, 1945. The new development in Elk Hills has been confined mostly to the previously proven part of the field, which constitutes only about one-quarter of the possible total productive area of the Elk Hills field, and this area is currently being subjected to rather heavy withdrawals. It would be desirable that any additional drilling required to maintain production at the authorized level during this emergency be extended over the large remaining untested parts of the field in order that the withdrawals can be spread uniformly over all parts of the field. Moreover, it would be highly desirable to initiate promptly sufficient exploratory drilling over the Elk Hills structure to prove-up fully the entire reserve. Only in this way can a determination be made of the productive capacity that could be called upon from this field in the event of an emergency.

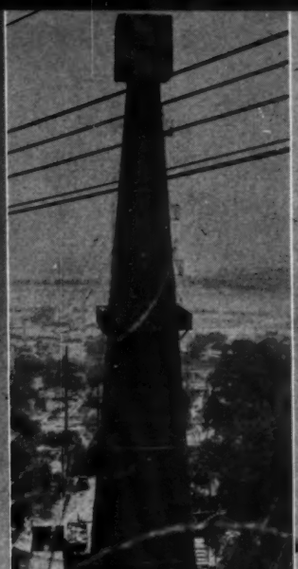
The importance of the increased production from Elk Hills to the total supply of California crude can be seen from an examination of the state's production figures since June 1944.

The figures show that total crude oil production in California has increased from roughly 850,000 barrels daily in mid-1944 to around 900,000 barrels daily in February 1945, an increase of about 50,000 barrels a day. Over the same period production from Elk Hills increased about 41,600 barrels daily which amounts to over 80 percent of the total increase in California production since June 1944. More-

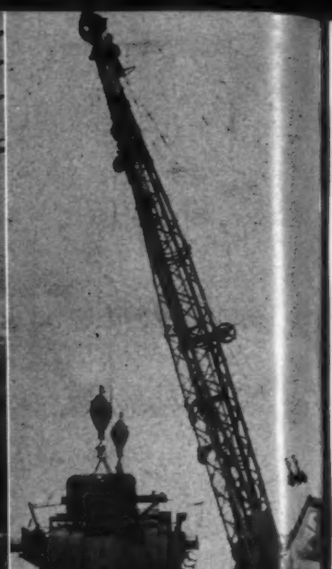
Moving Derrick to New Location in San Joaquin Valley.

Derrick Over Standard of California's KCL 20-13, World's Deepest Well.

Setting Engines Preparatory to Drilling in Elk Hills.



Soundproofed Well Drilled by Electric Power in Los Angeles.



Placing Draw-works in Position for Drilling.

over, it is important to note that California production outside of Elk Hills reached a peak in September 1944 and has declined over 20,000 B/D since that time. The figures are as follows:

Crude Oil Production in Barrels Daily

1944	Total California	Elk Hills	California Without Elk Hills
June	847,900	15,273	832,625
July	852,000	16,862	835,135
August	858,800	17,628	841,170
September	887,700	21,416	866,280
October	880,400	28,402	852,000
November	878,100	34,766	843,330
December	885,200	42,138	837,162
1945			
January	899,400*	48,792	844,608*
February	900,000*	56,879	843,121*

*Preliminary

Another factor in supplying the increased military demand for California oil has been the extensive development of dry gas production. It is estimated that the equivalent value of approximately 70,000 barrels daily of fuel oil was saved in 1944 through substitution of dry natural gas. The importance of the development of dry gas reserves in California is strikingly emphasized by a comparison of the dry gas production rate in 1941 and in 1944. Dry gas production in 1941 had the equivalent value of approximately 6,339,000 barrels of fuel oil, whereas in 1944 this equivalent value had increased to approximately 32,083,000 barrels. This comparison has further significance, since the increased dry gas production rate paralleled a constantly increasing gas production from oil fields during the same period resulting from the increased oil production rates.

Despite the record production of crude oil in California, and the substitution of gas for fuel oil as referred to above, crude production has not been sufficient to keep all refineries in the state operating at capacity. As a result, total above-ground stocks of California crude oils have declined by over 40 percent during the past three years, from 45 million barrels in March 1942 to approximately 25.5 million barrels at the present time. Since stocks are now closely approaching what is considered minimum working levels, further drafts on stocks should not be counted upon to assist substantially in meeting crude requirements. Lately, some crude has been moving into California from outside sources. At present, about 14,500 barrels a day of West Texas oil is moving by rail to California refineries, and it is anticipated that if transportation facilities will permit as much as 42,000 bbls. daily may be moved to keep all refineries operating at capacity.

Exploration for new reserves in California has been carried on at high rate since the beginning of the war, and in 1943 and 1944 a record number of wildcats and new pool tests were drilled. However, the results of the expanded exploratory drilling program have been somewhat disappointing from the standpoint of crude oil discoveries, although several new important gas fields were found in the central California gas area. Outstanding among the new oil discoveries in 1944 was the new 27-B Sand in the Buena Vista Field in Kern County. The relatively poor results of the 1943-1944 wildcatting activity in California emphasize the need for more intensified exploratory activity in the current year. While additional development in proven fields will probably serve to offset partially the normal decline in productive capacity, it is only through the discovery of new fields and pools that we can now expect to maintain over-all crude oil productive capacity in California up to the level of the present high production rates. In this connection, it is significant that at the current rate of withdrawals California is producing about nine percent annually of its proven oil reserves. This is to be compared with the 6.7 percent for PAW District 3 and 7.9 percent for the nation as a whole. This relatively high withdrawal rate in California cannot be maintained unless future new reserve discoveries are substantially greater than in recent years.

The exploration of California offshore tidelands is a development which a number of geologists believe may provide a major source of new oil. Large potential oil fields are believed to exist under the Pacific Ocean along the coast of California, but these have remained untested because of existing statutes. Should the exploration of the tidelands get under way promptly, large new reserves of crude oil might be uncovered in time for use against our enemy in the Pacific.

There has been a great deal of speculation as to the impact of V-E day upon the California oil industry. We do not expect that the end of the European war will change the over-all crude requirement situation in California or in any other producing area. While there may be a temporary reduction in the demand for certain types of petroleum products after V-E day, it is clearly indicated that all producing areas, not only in California, but throughout the entire United States and Western Hemisphere, will be required to maintain production at approximately current levels to supply the Japanese war. Because of its proximity to Pacific operations, the California oil industry must continue to play a major part in fueling that war. Accordingly, we are programming production in California throughout 1945 at maximum efficient rates averaging some 910,000 barrels daily.

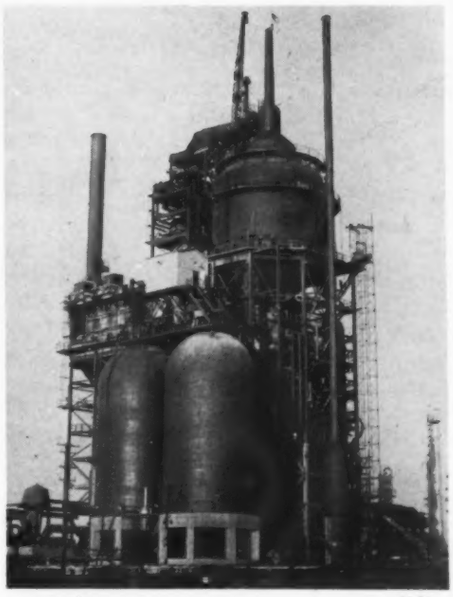
NEW WAR PLANTS TO PROVIDE "CUSHION OF SAFETY"

PAW's expansion of 100-octane production by scheduling of five new plants and consideration of several more is not only to meet rising military demands but to provide a cushion of safety. The increases in production asked by the armed forces are said to be "substantial" and the additional facilities to be built are the result of long-range military estimates by the joint Chiefs of Staff.

Plants approved by PAW and scheduled include one for the Texas Company at Lockport, Ill.; two for Standard of Indiana at Whiting, Ind.; and Sugar Creek, Mo; one for Leonard Refineries at Alma, Michigan; and one for Shell at Houston, Texas. The new facilities will be built entirely by private capital at a cost of $78,000,000. WPB is in the process of approving use of critical materials for four of these, while priorities for the fifth await clearance relating chiefly to manpower available at Houston.

"There are certain unpredictable factors in our wartime refinery operations which make it unwise to count on maximum capacity output", according to Deputy Administrator Ralph Davies. "An obvious one is fire. Our Facility Security Division and, I believe, all responsible men in the refining industry are very watchful about this, but the possibility of a major, damaging fire cannot be ignored.

"We have occasional shut-downs for emergency reasons, and our thermal cracking equipment in particular is working so far beyond normal capacity that it is going to have to be replaced in time. It also appears probable that transportation troubles such as we are experiencing this winter may prevent 100-octane plants from receiving their full capacity of feed stocks from time to time, with consequent decline from maximum production.



World's Largest Single Fluid Catalytic Cracking Unit at Avon Refinery of Tidewater Associated Oil Company, Employs U.O.P. Process.

"The future picture also is affected by uncertainty regarding manpower. We need some margin, therefore, between the absolute requirements of our armed forces and the theoretical capacity of our equipment. This fact is being considered in relation to the impending expansion."

The 100-octane output has been helped by diversion of some components from the synthetic rubber program. PAW has been informed, however, that this probably will continue only six months instead of two years. An expanded rubber program may even cut into the supply of cumene, blending agent that has accounted for 11.6 percent of the increase in 100-octane production. Also substantial supplies of toluene are being drained away from the manufacture of explosives.

There are now more than 60 plants producing 100-octane aviation gasoline and at least 150 more that are making major contributions in blending agents. Latest 100-octane plants to be put into operation are those of Tide Water Associated at Avon, Calif., one of the largest of its kind in the world, and of the Defense Plants Corporation at Richmond, Calif., operated under lease agreement by Standard of California.

National Refiners' Industry Advisory Council of OPA

Bottom row, left to right: Arthur Phelps, chief counsel of the Petroleum Price Branch; W. H. Beekhuis, Standard Oil Co. of California; Sidney A. Swensrud, Standard Oil Co. of Ohio, vice chairman of the group; C. L. Henderson, Vickers Petroleum Company, chairman of the group; M. E. Foster, Phillips Petroleum Company; Paul G. Blazer, Ashland Oil and Refining Company; Eugene Uman, price executive of the Petroleum Price Branch.

Middle row, left to right: Dr. Stewart P. Coleman, Standard Oil Co. of New Jersey; Neil Buckley, Taylor Refining Company; Joe L. Hill, Southport Petroleum Companyy; W. H. Bennett, Frontier Fuel Oil Corporation; C. F. Salzer, Gulf Oil Corp-Gulf Refining Company; Max M. Fisher, Aurora Gasoline Company; Roland V. Rodman, Bay Petroleum Corporation; J. S. Worden, Texas Company; B. L. Majewski, Deep Rock Oil Corporation; Harry H. Fuller, Sinclair Refining Company.

Top row, left to right: C. A. Johnson, Socal Oil and Refining Company; L. T. Cramer, Continental Oil Company; William L. Stewart, Jr., Union Oil Company; D. P. Hamilton, Root Petroleum Company; W. S. Zehrung, Pennzoil Company; J. L. Nolan, Farmers Union Central Exchange; Horace G. Dale, Shell Oil Co. Incorporated; John W. Boatright, Standard Oil Co. of Indiana.

SOURCE BEDS AND THE SEARCH FOR OIL

By Dr. O. W. Willcox

EVEN before the time of Drake the scientists had begun to study and speculate on the origin of petroleum and the causes of its migration and accumulation in the earth's crust. From what sort of material were oil and gas formed in the sands and rocks, and how did they become concentrated in the enormous pools that waited so long to be tapped by the drill?

While many geologists have speculated on this question, in the past many of them have regarded it as of only theoretical importance. No matter how it was formed by nature, oil is still always where you find it, and the petroleum geologist's chief concern is still to find the place where the oil is.

In recent times the petroleum geologists have come to see that the problem of the origin and accumulation is of something more than academic importance. The rate at which new reserves of oil are discovered has begun to slacken. Pools easily found by ordinary geological and geophysical methods have become scarcer. It appears that perhaps most of the structural traps that can be detected by seismic methods of exploration have now been found. The main hope for the future supply of oil is coming to be focused on stratigraphic traps, the finding of which is more difficult and calls for a broader knowledge of how oil was formed and has moved about from one place to another in the bowels of the earth.

Therefore, the petroleum geologists have lately begun seriously to take stock of their combined knowledge of the migration and accumulation of petroleum and natural gas. A committee undertook to round up what information could be found on the subject in the literature of oil geology, and in addition the committee circularized a questionnaire among working oil geologists asking for reports on their observation on how oil appears to have been formed and subsequently accumulated in underground reservoirs. All this body of information and opinion has now been put together in a book*.

From the consensus of these reports and opinions it appears that oil and gas have been formed and moved under a variety of conditions. There is general agreement that the mother substance of all petroleum hydrocarbons was dead organic matter—remains of animals and plants—that was deposited in waters where sedimentary material, that later became sandy or shaly strata, was being accumulated. While the details are infinitely varied in particular cases, the general picture is about as follows:

It is generally agreed that in all or at least the great majority of cases the accumulation of oil has been in connection with geographical basins in which sediments are being deposited. These sediments may consist of sand, mud, or loose limey materials mixed with a small proportion of decaying organic matter. The history of such depositional basins is nearly always the same; they gradually fill up with material carried into them from the land, so that the weight of material on the bottom of the basin increases. Meanwhile the organic material in the sediments is gradually transformed into hydrocarbons, which remain attached to the grains of sand, clay or lime carbonate. As the thickness of the column of sediments increases, the weight of the overlaying strata begins to squeeze the lower and older deposits and as the result of this pressure the liquids enmeshed in the muds are forced to escape, much like water escapes from a squeezed sponge. Under this pressure both the oil and the water of the squeezed mud will migrate either vertically, laterally or downwardly into any adjacent formation, generally a porous sand, that has enough vacant pore space to accommodate them.

However, it has been proved that no pressure can squeeze all the oil out of a mud, so that some of it, mostly material of high molecular weight that is in some sort of loose chemical combination with the mud, remains to form part of the final product of squeezing and hardening process—an oil shale, from which more oil can be artifically extracted by application of heat. Hence, every shale in the geological column is to be regarded as a most likely source bed from which free oil has migrated, and the problem of the oil geologist is to track this oil to its final resting place, which may be near or remote. While it is quite possible that oil and gas may travel long distances underground if presented with suitable paths, it is also possible that they may have found lodgment in nearby porous reservoirs of either the anticlinal or stratigraphic type. Hence, the presence of a shale or other formation that can reasonably be suspected of having been a source bed is an indication that the geological conditions of the vicinity should be extensively examined.

The squeezing process by which oil was expelled from the muds in which it originated is not applicable in the same form to sands that have functioned as source beds. Here a different process has served to drive out the oil and water. This is known as the cementation process, and is supposed to proceed as follows: As the oil-impregnated sand is buried under successive layers of other deposits, it is subjected to increased pressure; but as sand grains are not compressible the volume of the sand grains, or the pore space between them, is not much reduced by squeezing. However, under the combined influence of heat and pressure, the sea water entangled with the sand begins to deposit material in the pore spaces, which has the effect of more or less cementing the sand grains together with solid material that leaves no space for the oil and water. The latter are thus forced to migrate into whatever free space may be available to them. Not all of the oil may be squeezed out of the sand by this process. Some may remain behind as a stain, or "oil show" to indicate that oil once was there, and the sand is revealed as a source of bed, or that it has afforded passage to a migrating body of oil that may be trapped somewhere in the near or remote vicinity.

Although there is an infinitive variety of cases to be considered, the above contains the backbone of the present theory of how oil originates in its source beds and starts to move out of them. Naturally, it has to have some place to go. It will almost certainly find a temporary if not a permanent resting place in any unconsolidated sand or porous limestone that may be adjacent to an oil shale that is undergoing compaction, or an oil-bearing sand that is undergoing cementation. Among the simplest of such cases are the "shoestring" oil sands of Kansas and elsewhere. These shoestring sands are long, narrow sand bars that were built up along the shores of ancient seas, in which there were also being accumulated muds rich in organic matter. The mud and the sand bars were later buried: the muds became shales from which the oil was expelled by compaction into the old sand bars. This is somewhat of an oversimplification of a complex process, but it illustrates the relation between the source bed and the ultimate oil reservoir, a relation which it is more and more of interest to trace in an intensified search for oil.

Not all oil reservoirs are in the form of old sand bars. The natures of these reservoirs are greatly varied, but in the great majority of cases they originated in the course of the subsequent history of the geographic basins in which old organic matter was transformed into petroleum. When thousands of feet of sediments are deposited in an ancient sea, the bottom of the sea sags under the pressure. This pressure is felt not only in a downward direction, but also laterally in the direction of the rim of

**The Migration and Accumulations of Petroleum and Natural Gas, by F. M. Van Tuyl, Ben H. Parker, and W. W. Skeeters; prepared under the sponsorship of the Colorado School of Mines and published as No. 1 (Vol 40) of the Quarterly of the Colorado School of Mines, January, 1945.*

the basin. Under this compressive force, which may be assisted by earth movements of a different origin, the strata of the basin are wrinkled and folded; anticlines, monoclines, synclines and other structures are formed in which migrating oil and gas may be trapped. The basin may also be subject to upheavals which expose the strata to erosion, and depressions in which new sediments may create stratigraphic traps. Also, there is usually faulting and fissuring by which the hydrocarbons may escape from one trap and find their way to another.

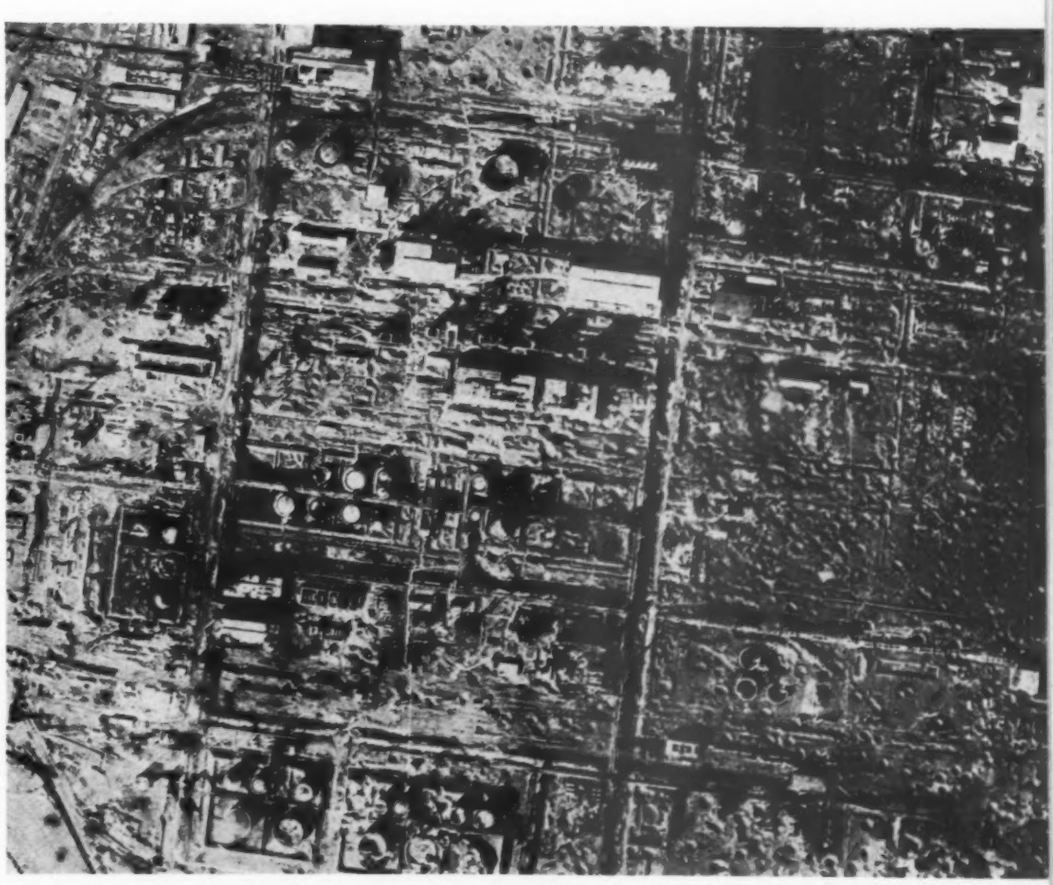
The next phase of the study of the relation of the place of the origin of oil to its final resting place is intensified study of each of the several types of petroliferous provinces. Further extensive investigation must also be conducted to bridge, as much as possible, the large gaps in our knowledge of the subject.

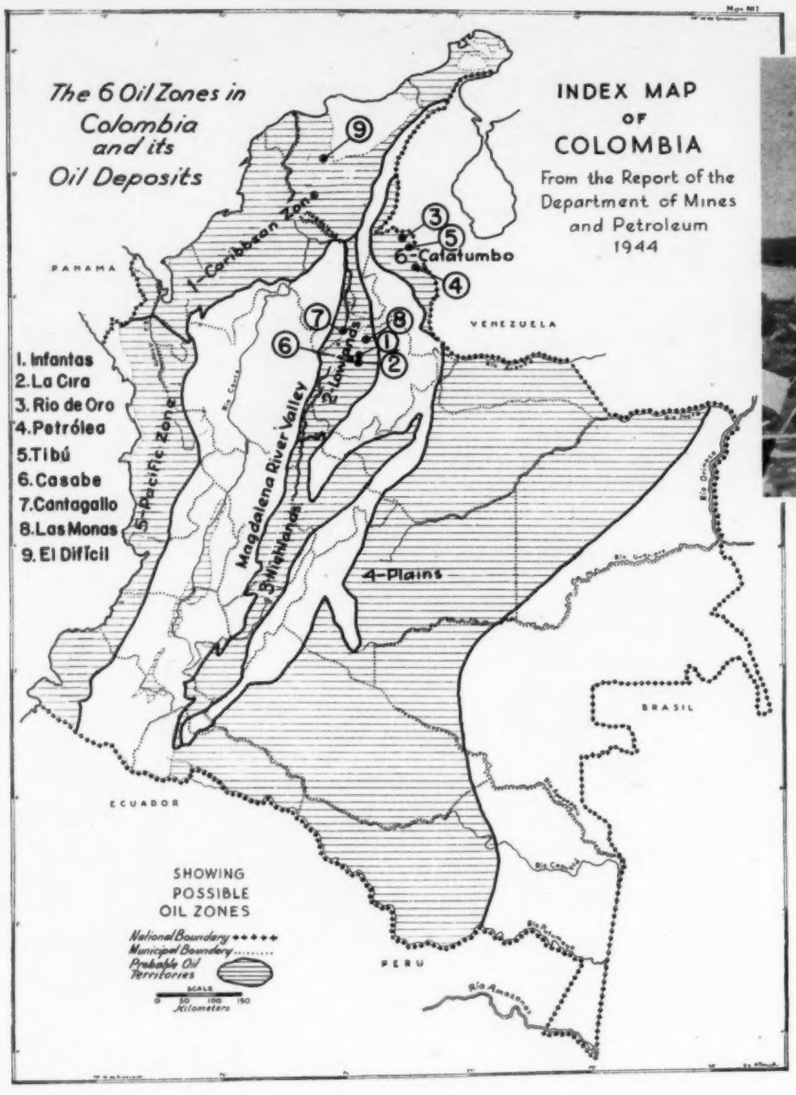
Large-scale paleogeographic studies and paleogeologic must be undertaken in order to increase our understanding of the time of origin and accumulation of oil and of the nature of source beds and their relations to the reservoirs. Oil well sampling and microscopic examination of the samples must be carried out with ever-increasing thoroughness, in order to increase our knowledge of the nature of reservoir horizons and overlying and underlying sediments. Many barren structural and stratigraphic traps must be thoroughly studied, in an effort to determine the conditions contributing to their lack of productiveness. Much remains to be learned regarding the underground movement of fluids, both through ground-water studies in the field and experiments in the laboratory. It is quite possible that our knowledge of currents generated by the sedimentary compaction can be increased by studies in certain basins of active deposition. Studies of oil-field temperatures and pressures, and oil-field waters must be continued and expanded. Our knowledge of capillary phenomena and of all the laws of fluid flow must be amplified by experimentation and new experimental techniques must be developed, in order to eliminate ambiguity from the results of such investigations. These problems call for the cooperative efforts of geologists, physicists, chemists, and petroleum-production engineers.

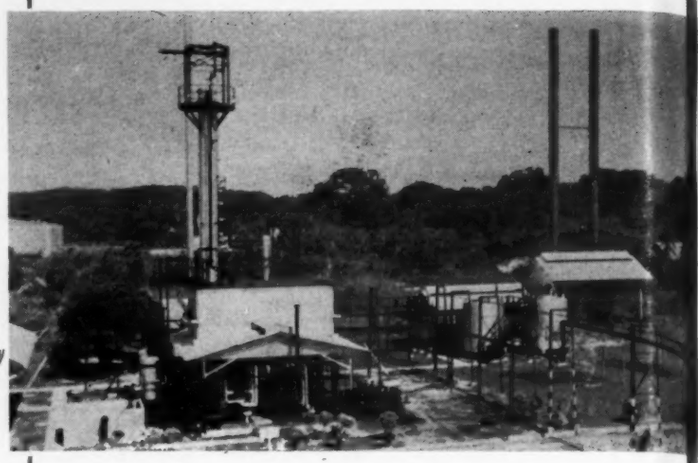
The practical solution of the problem, however, demands both a regional and a local treatment. If certain geologists, physicists, and production engineers in each petroliferous province in the United States could be prevailed upon to work in cooperation on this problem under a regional committee, it does not seem unreasonable to hope that, within a comparatively short time, a workable hypothesis could be developed for each area. Features which these various regional hypothesis have in common could ultimately be incorporated into a comprehensive theory applicable to new and little-known areas. Regional hypotheses might also be applied directly to new productive areas by analogy.

Top Picture Shows German Synthetic Oil Plant at Zeitz Near Leipzig, Before It Felt the Weight of Allied Air Attack. The Plant Employed About 5,000 Workers and Its Output Was Equal to That of Some of the Largest Plants in the Ruhr.

Bottom Picture Shows Same Plant a Month After Allied Air Attack. Plant is a Mass of Debris Amongst a Dense Concentration of Craters. Most of the Pipelines Are Broken and All Vital Parts of Plant Have Been Hit.







Topping Plant at Petrolea in the Barco.

Results of Oil Exploration in Colombia

By E. Ospina-Racines

DUE to orographic configuration the Andes, Colombia, is divided into two principal parts: (1) the tropical zones with altitudes up to 2,000 meters above sea level, and (2) the temperate and cold zones where there are elevations above 2,000 meters. This physiographic classification is shown by the accompanying index map, which also shows the possible oil zones of Colombia. The six oil zones are in the tropical regions.

As may be seen from a geological map of Colombia the oil zones of the country here outlined are large extensions of terrain covered by Cenozoic formations, including the Quaternary, upper Tertiary (Miocene-Pliocene), and lower Tertiary (Eocene-Oligocene). The total extension of these formations is estimated at 20,000,000 hectares, and represent that part of the country which is considered to have oil possibilities. Fifty percent of this area is in the district of Los Llanos, which is 1,000 or more kilometers from Caribbean tide water.

Since 1935 an intensive activity has been manifested in Colombia on the part of petroleum enterprises with the object of locating new oil deposits. The scale of this activity may be measured by the extent of prospective oil land that has been contracted with private interests, and the area covered by applications for concessions laid before the national government. According to the 1944 report of the Minister of Mines and Petroleum presented to the National Congress, the exploratory work accomplished in recent years has resulted in contracts for subsoil rights as shown in Table I.

The area of 7,287,284 hectares comprised in the 103 applications and the 22 concession contracts is parceled out among the companies established in the country, as shown in Table II.

TABLE II

Enterprise	Area in Hectares
1. Richmond Petroleum Co.	1,401,117.7
2. Cia. de Petroleos Shell	1,030,851.6
3. Socony-Vacuum Oil Company	1,226,650.4
4. Texas Petroleum Company	1,232,508.9
5. Tropical Oil Company	1,983,232.8
6. Colombian Gulf Oil Company	300,655.0
7. Sinclair and others	112,267.9
Total ------	7,287,284.3

TABLE I

Recent Oil Explorations in Colombia and Contracts for Oil Rights with the Government and Private Individuals

Oil Zone (see map)	Government Oil Lands, Hectares				Private Oil Rights of Individuals, Hectares	
	Concession Contracts in Force	Area Covered By These Concessions	Number of Valid Applications for Concessions	Area Covered by Applications & Contracts	Leases (validity presumed)	Private Oil Property (title recognized by the government)
1. Caribe	7	305,289	49	2,658,321	319,541	5,816
2. Bajo Magdalena	11	812,903	13	703,381	138,119	15,000
3. Alto Magdalena	1	24,672	4	146,379	276,212	164,176
4. Los Llanos	4	399,294	29	3,406,271	31,904	10,000
5. Pacifico	–	–	8	372,932	–	–
6. El Catatumbo	1	186,805	–	–	126,965	–
	24	1,728,963	103	7,287,284	892,741	194,992

NOTE: The area covered by applications and contracts refers only to concession contracts coming under the petroleum law that has been effective since 1931; that is to say, exclusive of the De Mares concession of 512,000 hectares in Bajo Magdalena, and the Barco concession in El Catatumbo, covering 186,805 hectares; these two concessions were granted under special contracts in 1919 and 1931, respectively. They are the only ones that are now being commercially produced.

Exploration By Drill

In Colombia the law authorizes exploration by drill and production of the oil-bearing subsoil in two classes of lands: (1) national lands granted under concession which, as shown in Table I, cover a total of 1,728,963 hectares; and (2) private lands, provided that subsoil rights to oil under these lands has been legally recognized as private property.

According to the figures of Table I, to date the government has recognized 194,992 hectares as private property, that is, the owner of the surface is also the owner of the oil-bearing subsoil. The 892,741 hectares covered by contracts with private owners, as shown in the table, represent presumed rights in the subsoil which the government may recognize or deny according to procedures laid down in the petroleum law.

Aside from the 892,741 hectares contracted with private parties up to the end of the past year, the Phillips Petroleum Company has contracted for a property which covers about 300,000 hectares. The total of private property now under contract exceeds a million hectares. It is of interest to note that contracts for government concessions cover 1,030,185 hectares, after deducting the De Mares and Barco concessions, which were signed in 1919 and 1931, before the present petroleum law came into effect. The general result is that contracts under the law cover an area of more than 1,200,000 hectares whereon wells may be drilled in search of new petroleum deposits.

Drilling Results in Colombia

Exploration with the drill in search of oil deposits began in Colombia in 1907, and since that date to the middle of 1944 some 1492 wells have been drilled in the country; of these 1314 have been producers and 178 were dry. The latter represent 12 percent of the total.

The progress of exploration by the drill in Colombia may be divided into two stages. The first covers the period from 1907 to 1931, when the petroleum law came into effect; the second stage was from 1931 to the present. During the first stage, as gleaned from the records of the Ministry of Petroleum, there were drilled 81 holes, all on private lands, and all without success. During the second stage, up to the beginning of 1944, and also excluding the De Mares and Barco Concessions, there were drilled 58 holes. Two of these were on private lands and the rest on lands conceded by the government. The result of this activity has been the discovery of various deposits which are shown on the map in connection with the numbers 6 to 9. The deposits 1 and 2 are in the De Mares concession, and 3, 4 and 5 are the Barco concession.

The figures of Table III refer to the explorations by drill that were carried out in Colombia during the 9-year period. The result of this activity was the discovery of one commercial field, the Casabe, shown as No. 6 in the index map. Other discoveries resulting from this activity are the deposits marked on the map as follows: Los Monas, 8; Cantagallo 7 (both of these were found by Socony); and the Dificil 9, by Shell. The commercial posibilities of these deposits have not been proved, and at the present time drilling is going on to determine these possibilities.

By all this activity there has been proved the existence of one oil deposit that is commercially productive. It will be interesting to observe the further development being carried on by the Shell Company, which discovered the Casabe deposit. On December 10, 1938, Shell began drilling the first exploration well, and on July 2, 1940, began drilling the seventh well without positive results. On March 12, 1941, it began drilling the Casabe well, which was the discovery well of the field. That is to say, the eighth well was a success.

Shell has pursued its exploration program and in other zones of the country has drilled two other wells without positive results. On July 18, 1942 it began drilling the Dificil wells, where well No. 3 shows the possible existence of a commercial oil deposit.

Shell's experience during the period 1938-1944 may be summarized thus; (7) wells; one commercial deposit; two other wells and another deposit, possibly commercial. On the other hand it may be seen from the data of Table III, that other enterprises, equally assiduous during the same period of nine years, have not attained a comparable success.

According to general experience throughout the country, the first wells on the concessions in Colombia represent investments of from $800,000 to $1,800,000, comprising outlays for the following purposes: organization of the enterprise, acquisition of the concession, the machinery and tubing for drilling, camps for the personnel, roads, technical studies (including geological and geophysical), and the drilling of one or two wells to an average depth of 7,000 feet (2200 meters).

Experience in this country during the last nine years indicates that from the time of filing an application for an oil concession, it takes about 4½ years to go through all the administrative red tape and the technical preliminaries for drilling the first 10,000-ft. well.

The Oil Fields

The oil fields of Colombia discovered to date are indicated on the accompanying map. Nos. 1 and 2 are in the De Mares concession where, since 1916, there have been drilled 1147 productive wells out of a total of 1189 drilled holes. About the middle of 1926, commercial production of the Infantas and La Circa fields began, and up to the end of 1944 there had been produced 331,392,152 barrels of oil, an average of 290,000 barrels per well.

The deposits marked 3, 4 and 5 are in the Barco Concession, where since 1933 there have been drilled 152 producing wells out of a total of 168 holes drilled up to the end of 1944. The cumulative production up to the end of 1944 was obtained almost exclusively from the Petrolea and Tibu fields, and amounted to 17,047,678 barrels. The average production per well to date has been 112,000 barrels. Commercial production of the Barco concession began toward the end of 1938.

In the Casabe field, No. 6 on the map, there have been drilled to date a total of 26 wells, of which 25 have been producers, with proved potentials varying from 106 to 1200 barrels per well per day. The present calculated reserves amount to about 190,000,000 barrels of oil of 21.5°A.P.I. gravity producible commercially. At the present time a branch pipe line is being built to connect the Casabe field with the Andian pipe line, and it is expected that initial production of from about 5,000 to 15,000 barrels a day will begin before the end of this year.

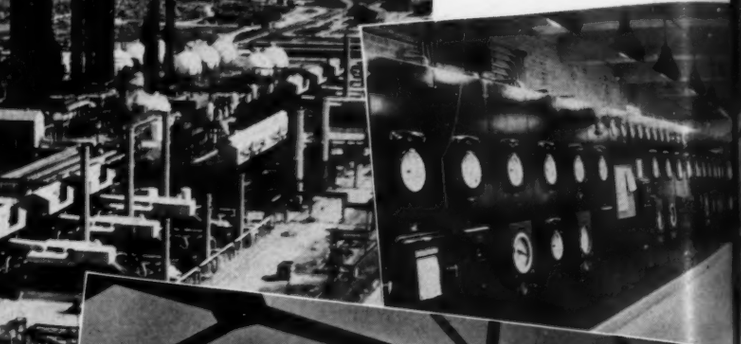
In the Dificil field three wells have been drilled, the first with positive results and the second a dry hole. No. 3 was finished with a daily potential of 750 to 1000 barrels of a light oil 42° A.P.I. At the present time, the fourth well is under way and others have been located.

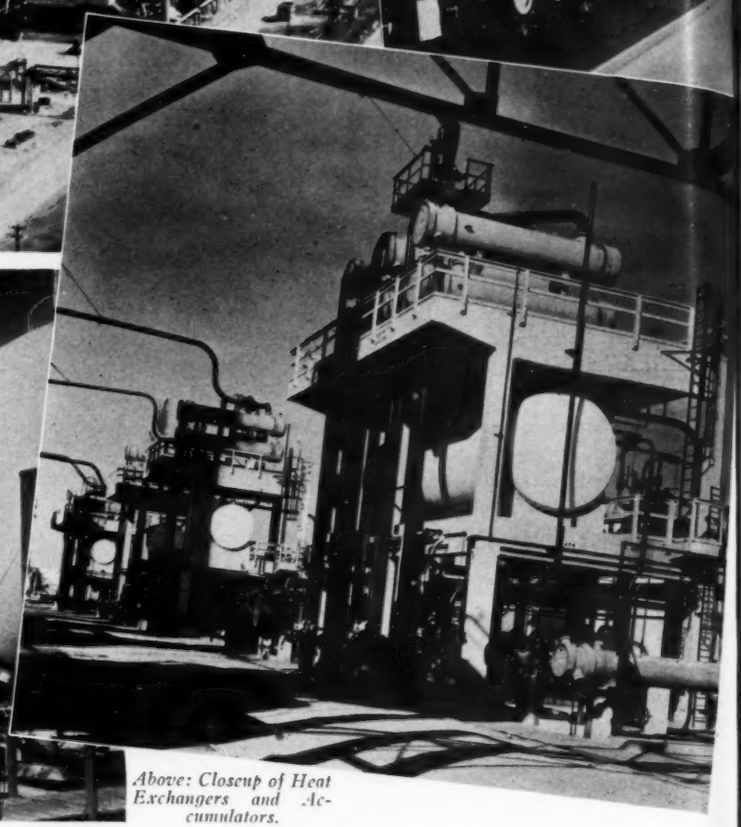
TABLE III
Wells Drilled in Colombia
in 1935-1943 by Petroleum Enterprises

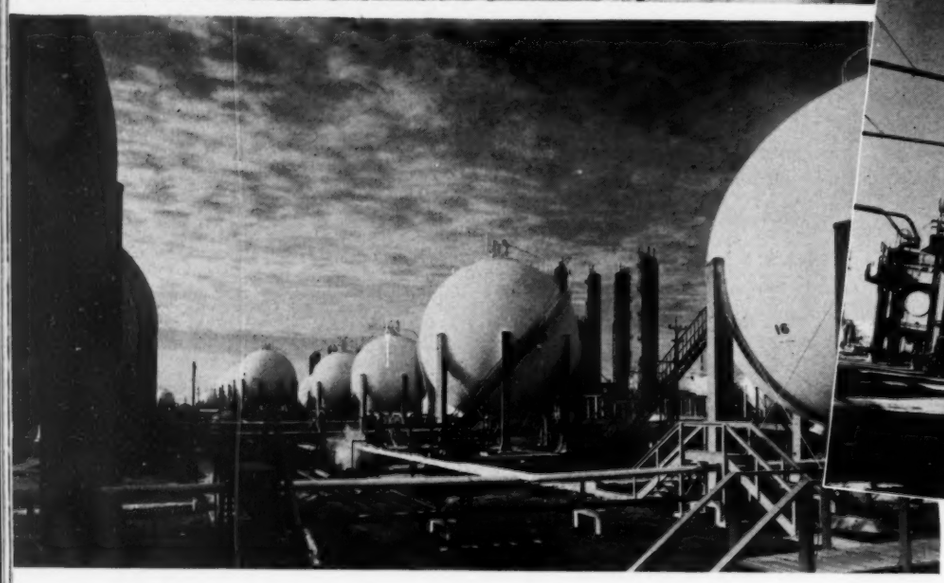
Wells Drilled	Tropical	Condor	Shell	Socony	Richmond	Total
Total Wells	8	18	7	11	13	57
Producers	0	13	1	2	0	16
Dry Holes	8	5	6	9	13	41
Period	'35-'43	'39-'43	'38-'43	'37-'43	'41-'43	
No. of Years	9	5	6	7	4	
Well Depths -						
Avg.Feet	6160′	4400′	10,100′	5800′	1400′	
Max. Feet	9502′	8202′	10,929′	10,740′	4273′	

NOTE: The Condor wells were drilled by Shell. The Condor Co., a subsidiary of Shell holds the Yondo concession where the Casabe field was discovered.

Below: Control Room —Recorder of Operating Conditions.







Above: Closeup of Heat Exchangers and Accumulators.

Above: Spheroid Tanks Are Used to Store Products.

Top: View of 100,000-Ton per Year Butadiene Plant.

NECHES PLANT IN FIRST YEAR'S OPERATION

Attains 150 Percent of Designed Capacity

By Neches Technical Committee*

BORN of wartime necessity as part of the synthetic rubber program to save the nation from catastrophe, the 100,000-ton per year butadiene plant of the Neches Butane Products Company has proved its value in the national emergency and has demonstrated the economic soundness of a peacetime synthetic rubber industry. With the passing of the rubber crisis, an examination of its excellent first year's record is both timely and significant.

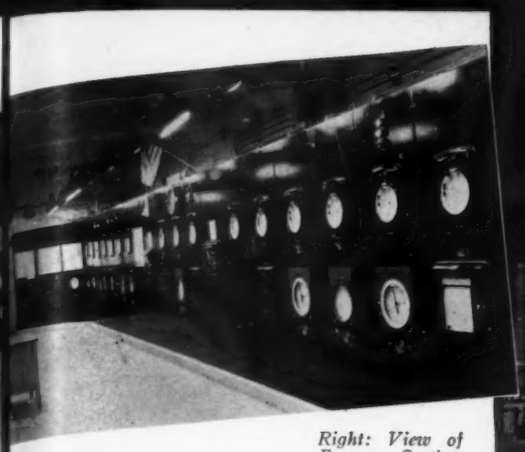
Shortly after the Japanese attack on Pearl Harbor it became apparent that natural rubber could no longer be obtained from the Far East in sufficient quantities and that a complete breakdown in the war effort could be avoided only by the tremendous production of a suitable synthetic. The seriousness of the situation was reported to the President and the nation by Bernard M. Baruch and his colleagues in their statement: "Of all critical and strategic materials, rubber is the one which presents the greatest threat to the safety of our Nation and the success of the Allied cause."

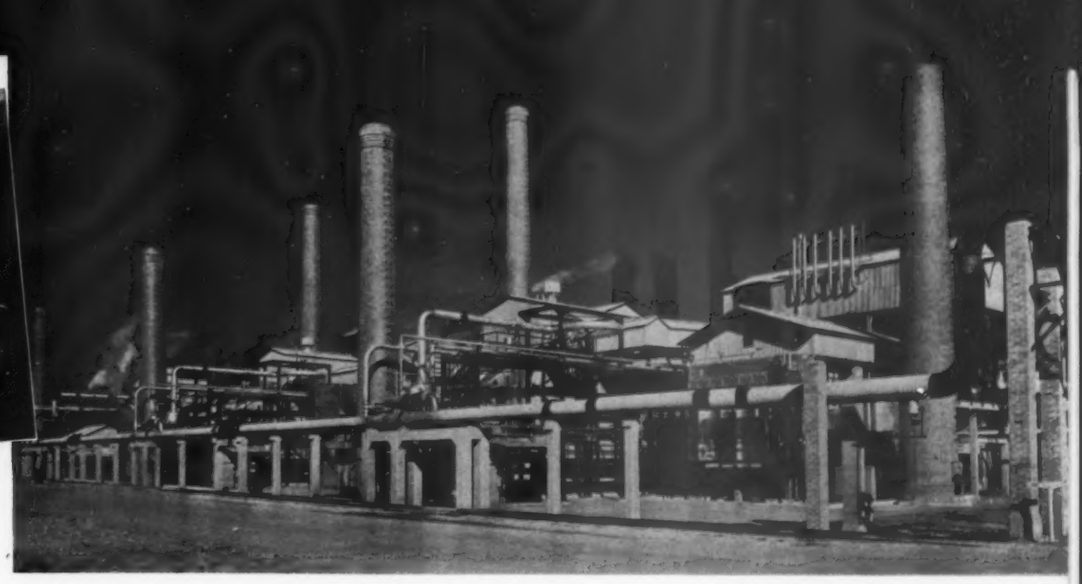
The development of a new synthetic rubber industry to meet the timetable of a global conflict and to replace in size that which was developed over several generations represents a triumph in the cooperative effort of American management, science and technology. This new industry required a large expansion of the country's moderate facilities for making the butadiene—styrene polymer, for increased quantities of styrene, and for the production of tremendous quantities of the major component—butadiene. Processes which had been used to meet the previous small scale butadiene requirements were incapable of expansion to meet the new demand. American industry had to develop new processes, build new plants, and operate them.

The extent of cooperation of competitive American companies in this gigantic undertaking is well illustrated by the story of the Neches Butane Products Company, the largest plant in the petroleum butadiene program. While this plant is rated at 100,000 tons of butadiene per year - sufficient to make 30,000,000 passenger car tires - each of the two units comprising the plant had operated well in excess of one and a half times its rated capacity.

Because the Port Arthur-Beaumont area in southeast Texas has the greatest concentration of petroleum refining capacity in the world, and because half of America's known gas reserves lie under the soil of Texas, it was natural that these resources should be used for a major contribution to the tremendous task.

**Committee consists of duBois Eastman, The Texas Company, chairman; P. W. Cornell, Gulf Oil Corporation; J. Happell, Socony-Vacuum Oil Co; C. A. Porter, Pure Oil Company; M. J. Fowle, Atlantic Refining Co.; A. H. Schutte, The Lummus Company.*





Right: View of Furnace Section.

In this area are the refineries of five large oil companies known to every motorist as vigorous competitors: Atlantic, Gulf, Pure Oil, Socony-Vacuum (Magnolia) and Texaco. These five companies could provide an unparalleled source of supply of raw materials, in a location where natural gas made available the enormous requirements of cheap fuel. Here also, was the technical know-how, the engineering and management personnel, and a reservoir of experienced operators, so vital to the project.

Under the leadership of Herbert Henderson, now chairman of the board of Neches, the five companies offered to pool their resources and to undertake the construction of a butadiene plant financed by the Defense Plant Corporation, and to operate it on a non-profit basis as agents of the Rubber Reserve Company. The services of The Lummus Company, a leading engineering and construction organization in the petroleum industry, were enlisted.

A Technical Committee, with one engineer from each of the five oil companies and an engineer from the Lummus Company, was appointed to survey all available data on methods of butadiene production, to recommend the best process design, to supervise the designing of the plant, and to assist in putting it in operation. On the basis of the Technical Committee's report, the government approved in March, 1942 the construction of a 50,000-ton unit, and in the following month authorized the construction of a second 50,000-ton unit. In less than two months' time the cooperative organization, Neches Butane Products Company, was incorporated and staffed by the five refiners, land was acquired at Port Neches, Texas, and the lease, operating, and construction agreements were executed. Ground was broken in June, 1942 and, less than two years later, in February and May of 1944, the two 50,000-ton butadiene units were producing a specification product.

The plant produces butadiene by the catalytic dehydrogenation of normal butylenes extracted from a butane-butylene mixture supplied from the five refineries. About 15,000 barrels per day of this mixture (containing isobutane, normal butane, isobutylene and normal butylene) are fed to the plant through part of a 52-mile pipeline system. Superfractionation alone is not sufficient for separating from the butanes a normal butylene stream of a purity suitable for dehydrogenation. Combined with extractive distillation in the presence of a specific solvent, the butanes are removed and returned to the refineries for aviation gasoline manufacture. The normal butylenes represent the fresh feed to the dehydrogenation process.

Dehydrogenation is carried out at low pressure and very high temperature in the presence of large quantities of superheated steam over a catalyst which is steam regenerated. The effluent, containing hydrogen and unreacted butylenes in addition to butadiene, is compressed and the C_4 fraction recovered by absorption, stripping, and fractionation.

The butylene-butadiene mixture is processed in three steps, two being superfractionation and the third extractive distillation in the presence of a selective solvent. As in the case of the butylene extraction system, the solvent used is furfural, a common system being used to keep the solvent in proper condition. The three purification system steps were designed to produce butadiene of a purity meeting the 98.5% specified for GR-S production, but have by careful operation been able to do considerably better.

The process steps were designed on data obtained from various sources. These data, together with the information required for the development of special equipment by individual manufacturers, were obtained from oil, chemical, metallurgical and rubber industries, from universities, from government agencies established to assist and direct the overall program, and from the laboratories of the five oil companies.

Plant design involved several serious problems. Among them may be mentioned the shortness of available time, the necessity for conserving critical materials, the factors inherent in developing large-scale designs from limited experimental data and, above all, the necessity for an integrated process which had to work. For example, the extractive distillation system in the feed purification section alone contains 480 fractionating trays in 12 towers, most of which towers are more than 150 feet tall. The 400,000,000 Btu/hr. heat input required to effect the necessary separation is supplied by steam; in terms of boiler plant requirements this represents the equivalent of some 18 tons of coal per hour. The butylene dehydrogenation plant includes a total of twelve 17-foot reactors.

Construction of the plant during wartime involved the solution of problems created by the extreme scarcity of essential materials, the shortage of skilled labor, and the congestion of transportation. American ingenuity and determination solved the problems. Vessel-fabricating shops were swamped with work and could not handle the fabrication of the many huge steel towers. Therefore, the largest continuous vessel-fabricating shop in the country was erected at the site with equipment scraped together by The Lummus Company, and the towers were welded in one piece. So large were some of the towers that the Army supplied special artillery cars to transport them to the point of erection.

Upon completion of the first Neches unit, there was a complete crew of operators, maintenance mechanics, laboratory analysts, and management personnel ready to put it into operation. Many of these men were drawn from the five participating refineries and had already been trained.

Control of operations to produce 99+% butadiene requires rapid and accurate analysis for the seven C_4 constituents in the various plant streams. This has been satisfactorily accomplished by means of infra red and ultra violet spectrophotometers.

The first year's operation has shown that the Neches butadiene plant can operate in excess of design capacity, but the ultimate capacity of the plant has not been proved due to the fact that the feed stock has been limited; military strategy made it necessary for the refiners to divert a portion of the feed stock to the aviation gasoline program.

Neches Butane typifies the cooperative spirit of American industry in the war effort—the spirit which caused Atlantic, Gulf, Socony-Vacuum (Magnolia), Pure, and Texas to depart from the competition of peacetime and, with the assistance of others of their competitors, join in helping to build a tremendous American wartime industry that has a bright peacetime future.

ECHOES FROM THE WASHINGTON OIL FRONT

By W. J. Maddox, *Chief of World Petroleum's Washington Bureau*

Planning Oil Shale Plant

R. R. Sayers

SELECTION of a site on the Naval oil-shale reserves in western Colorado for a $1,500,000 oil-from-shale demonstration plant completes one important step in the Bureau of Mines' five-year program for making synthetic liquid fuels. There remains the selection of a site for a demonstration plant to make liquid fuels from coal. Funds for construction of the plants and for a laboratory, to be built at Laramie, Wyoming, have been granted by Congress under the so-called O'Mahoney-Randolph Act.

Bureau of Mines technicians now are overseas examining recently captured German plants which made synthetic fuels from coal. Of the estimated 92 billion barrels of recoverable shale oil in the United States, nearly 48 billion are said to be in the formations about the Anvil Points area of the Naval Reserve, seven miles west of the town of Rifle.

Major parts of the Rifle plant will include a 200-ton-a-day shale mine which can be enlarged if necessary, a 1½-mile-long aerial tramway to carry the shale from the mine to the plant, and crushing and retorting equipment of a capacity adequate to provide useful information on methods of operation and costs for private industry. A shale-oil refinery of pilot-plant scale will be added later when the technical information needed for its design and construction is obtained by the research and development laboratory.

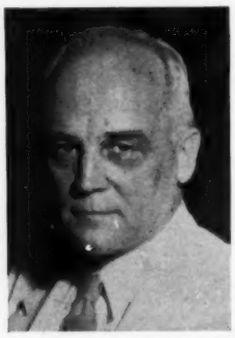
Optimistic Outlook

PIWC Chairman William R. Boyd, Jr., looks for the petroleum industry to reach even greater heights of achievement after the war provided American inventiveness and ingenuity are not regimented. Speaking at a dinner given by the First National Bank in Dallas, Texas, honoring the oil fraternity of that city, Boyd said:

"The processes that have been developed by our industry in the course of this war for the production of the super fuels, the almost magic lubricants, the toluene, cumene, butadiene, and other war products, have made possible the tremendous advances on every fighting front where our boys are outslugging our enemies. Are we to believe that this typical American inventiveness and American ingenuity will cease with the end of the war? Are we to believe that after the war this great generation of brave young men, now in uniform, will not attack and conquer new frontiers of scientific achievement with the same zeal they have displayed at the fighting fronts?

"The answer is obvious. The petroleum industry is on the threshold of tremendous advancement if we here at home keep and guard that very special freedom of enterprise that is responsible for human progress. Without initiative and daring the other freedoms are sterile."

Senators Report on Mid-East



James M. Tunnell

TWO Senatorial far-travellers—James M. Tunnell of Delaware and Harold H. Burton of Ohio — returned from an inspection of military installations with a rather glowing impression of the petroleum possibilities of the Middle East. Each Senator, travelling on behalf of the Mead (formerly the Truman) Committee, made a full report to the Senate, which has now been published as Senate document No. 9.

Stating it as the "belief of many oil men," the Delaware Senator told the Senate that there are resources in the Middle East of 200 billion barrels of oil. "The question of striking oil by wells is not one which disturbs the oil producers of that region," he declared with an Aladdin touch. "Tremendous quantities of oil can be reached by comparatively few wells." However, he pointed out, those wells are not in the section of the world where oil can be profitably consumed.

The Abadan refinery, from a "very few wells," Tunnell related, is refining and marketing 300,000 barrels of oil a day. Within a comparatively short time, he predicted probably 500,000 barrels of oil a day will be refined in this area.

While American interests own approximately fifty percent of the oil prospects of the Middle East, Tunnell said, they control at this time a very small percentage of the output. Even pipe lines for oil pumped on American leases would probably cross lands controlled by other governments.

"The Middle East oil region situated somewhere near the original Garden of Eden," the Delaware Senator said, "is close to the center of world's population, but is far from the center of the world's use of oil. There are those . . . . who believe that the enormous quantities of oil which will be produced in that area are capable of materially raising the standard of living and of civilization in that area.

"It seems unbelievable and undesirable that this great storehouse of wealth should be removed and transported to other sections of the world with the vast population of Asia living around it and capable of developing itself in civilization by the use of oil. The removal of this oil to the people of the world where it can be used involves tremendous transportation charges. However, your committee believes from all that it ascertained in its investigations that it is unlikely that any great increase in oil for this world war can be obtained from the middle eastern fields, due to the lack of refineries and transportation facilities. Your subcommittee believes that our government should take into consideration this situation in its broadest aspects at the peace table."

Harold H. Burton

Tunnell said the Adaban refinery is being used for production of high octane gasoline. All possible steps are being taken, he said, to use the oil of that region in the war effort, but there are not the refineries and there are not adequate pipe lines to make it possible to use as much as the region is capable of producing.

China's Oil Needs

ACCORDING to the National Planning Association, China will need close to 100 million gallons of gasoline the first year after peace is restored, twice its "normal" requirement in pre-war years. A very small fraction of this, it is said, is produced domestically, the rest imported. A report by the Association says:

"Free China's production of gasoline was only 1.8 million gallons in 1942. Oil reserves in occupied China are negligible, and only a small amount of shale-oil is produced in Manchuria. Since 1942, Free China's production has gone up somewhat, but in all probability is still less than 4 million gallons per year. In short, China

does not produce enough to keep more than perhaps a thousand trucks operating. China's output of gasoline can be somewhat augmented by sending in refining machinery; but, even so, China will continue to rely upon imported gasoline."

Chinese estimate submitted to UNNRA indicated a need of more than 34,000 motor vehicles, largely trucks, during the first year and a half, with an average weight of three tons.

New Post for Disney

Wesley A. Disney

WESLEY A. DISNEY, former Congressman from Oklahoma, who has been closely identified with oil legislation for the past several years and sponsored the bill for an increase in crude oil prices for which he fought vigorously at the last session, is not to be lost to Washington despite his defeat for reelection last November. A recent announcement by Don E. Gilman, executive vice president of Western Oil and Gas Association, states that Mr. Disney has been appointed to represent the Association in the national capital. Mr. Gilman states that through this appointment it is hoped to establish a closer relationship and better understanding between the federal departments and bureaus and the western oil industry.

Pew Criticises Oil Pact

SUN OIL President J. Howard Pew terms the proposed Anglo-American oil pact initiated last summer as "illustrative of the mischief done by premature postwar planning." In his annual report to Sun stockholders he says; "While this undertaking had nothing to do with the conduct of the war, nevertheless it seems to most of those in our industry that the ratification of such a treaty would have defeated the very purpose for which the war is being fought.

"The same stifling of competition and economic opportunity that was present in the old NRA codes now reappears in the guise of an international trade record—a super-state cartel—an international monopoly under the control of government. The oil executives were compelled for many months to devote a large amount of their time and energy to a discussion of this subject when they should have concentrated their efforts on the production of war materials."

Pew also laid the whip on cartels. "By and large," he told his stockholders. "the greatest danger threatening economic progress in America is the growing movement to cartelize world trade under government control through so-called "trade accords". This means, of course, cartelizing American domestic activities as well as international trade for the two cannot be separated into isolated compartments. Moreover, the only difference between cartels among private enterprises and cartels controlled by government is that the latter are more reprehensible. This whole subject is fast becoming the most challenging issue ever to confront the American people".

Tide Lands Control Up Again

A very touchy subject which intermittently bobs up in Washington was brought again to the fore by the statement of Representative Carl Hinshaw of California that Petroleum Administrator Ickes was about to grant one or more leases for drilling in the tide lands area of that state. The question whether authority over these offshore areas resides in the federal or state governments is one on which violent disagreement exists. Secretary Ickes, undoubtedly, would like to establish the right of the national government to tide land control and the fact that drilling in such locations might add substantially to Pacific Coast production at a time when more oil from that territory is urgently needeed for war use may have convinced him that now would be a favorable time to raise a test case. Any such move is certain to stir up a first class row because there are other states—Texas, Louisiana and Mississippi for example—with coast waters that are considered excellent prospects for production. There is no doubt where Texas will stand on any such issue and one of the grounds given by Representative Hinshaw for his statement was the assertion that Mr. Ickes had tried to find out from Gov. Bailey of Mississippi the attitude that would be taken by his state.

Death Knell of Canol

Senator Ed Moore

FINAL knell apparently has been sounded on the much debated Canol project which has been the object of repeated attacks by members of Congress ever since it was first undertaken. It has been the pet aversion of Senator Ed Moore of Oklahoma who contributed a few scathing remarks to the discussion which attended the announcement of the abandonment of the enterprise. Operating charges for the past six months, he said, had been far in excess of the value of all production at the White Horse refinery since it started operation. "Silly, childlike and bull headed" he characterized the attitude of the War Department in persisting in an undertaking that cost $134,000,000 against the advice of oil experts and of the Mead committee which had investigated the project and found it particularly worthless. It was Senator Mead, chairman of the committee, who imparted the information that no more oil was being sent through the Canol line and that the whole works would be closed down on April 1.

Along with the abandonment of the pipe line and refinery will go the probable disuse of the Alcan highway on which approximately $139,000,000 was spent. Title to the highway passes to Canada at the end of the war but the prevailing opinion is that the Dominion government will not care to support it and that the provincial governments will be unable to do so. The Army still maintains that the building of the highway and the pipe line was justified by the threat of Japanese invasion in 1942 but apparently is willing to admit that danger on that score is past and that the $1,000,000 a month that the project is costing might as well be saved.

PAW Apointments

William R. Argyle

BONNER BARNES, formerly general superintendent of Gulf Oil Corporation refineries in Texas, has been appointed assistant director of the refining division of PAW. He succeeds William R. Argyle, who has been named associate director. Mr. Argyle has served as assistant director since September 1943. Prior to that time he was assistant manager of refineries for Sinclair Refining Company.

High Priced Drilling Rights

ALL records for the largest amount of money ever offered the U. S. Government for the privilege of drilling for oil on one acre of federal land were twice shattered in the same year by the General Land Office in leasing public land for development during the 1944 fiscal period. Both record-breaking bids were offered for land in the same area—the Elk Basin. In August 1943 a bid of $5,800 smashed all previous high offers for 1-acre drilling rights. Three months later a bid of $26,216.21—nearly five times the previous high—was made to set an all-time peak. Altogether, nearly $3,000,000 was paid the government during the year as bonus bids for drilling.

Keeton Joins PAW

W. PAGE KEETON who has been price executive in the petroleum division of OPA since September 1944, has transferred to the Office of Petroleum Administration for War as assistant chief counsel. Mr. Keeton is a Texan who graduated from the University of Texas law school in 1931. From 1932 to 1935 he was a member of the law faculty. [He served as assistant dean of the law school until he joined OPA in 1944.]

U. S. Reserves G

A. P. I. Committee Reports Additions of 2,067,500,000 Barrels Bringing Total to 20,453,231,000 — Discoveries of 511,308,000 Barrels Largest Since 1938.

ALTHOUGH it had been generally assumed that the record breaking withdrawals of crude oil from the fields of the United States during 1944 would have resulted in a decrease of the country's known reserves, a different conclusion is reached by the Commitee on Reserves of the American Petroleum Institute. It is the function of this committee to make an annual survey of reserves including increases due to discoveries of new pools and also additions attributable to extensions of previously known fields. The committee is made up of geologists and production officials representing all sections of the country. It has access to information collected by individual oil companies and by state authorities. Its findings are estimates but they are estimates based upon past experience and upon the best known methods of measuring the probable contents of underground reservoirs. As such they probably are more nearly accurate than figures that could be arrived at by any other group or by any other method.

Surveying the course of exploration and production during the twelve months of 1944 the committee reported to the API board of directors a net gain in the known reserves of the United States of 389,079,000 barrels. Discoveries of new pools opened during the year are credited with 511,308,000 barrels. Extensions of existing fields and revisions of their estimated contents are placed at 1,556,192,000 barrels. From this total of 2,067,500,000 barrels is deducted the actual production during 1944 of 1,678,421,000 barrels leaving the net gain as stated above and bringing the total of known reserves to 20,453,231,000 barrels as compared with 20,064,152,000 reported at the end of 1943.

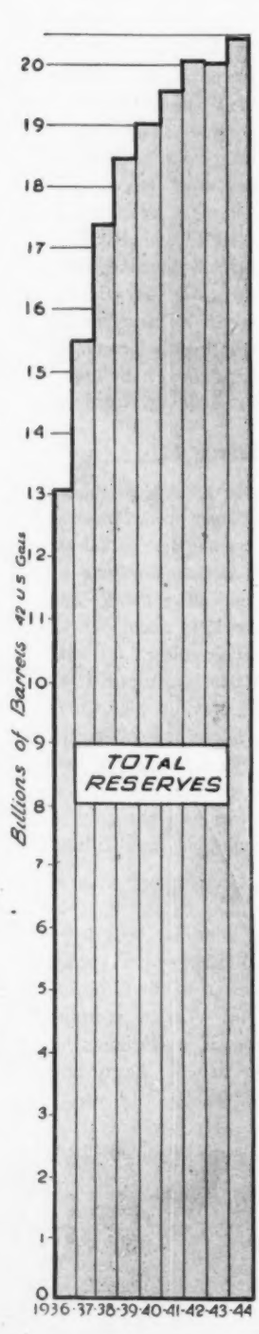
There are several significant points about this report. As in other preceding years the major part of the addition to reserves, actually 75 percent, was accounted for by extensions and revisions applying to previously known fields. On the other hand the discoveries of new pools were greater, both actually and proportionally, than in any year since 1938, showing that the intensification of exploratory drilling during the past year was not without effect even though few pools of major size were located.

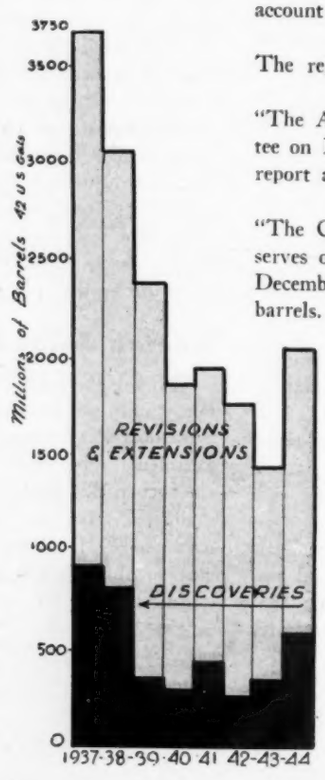
Texas as usual led the way in additions to the reserve with 747,790,000 barrels but in discoveries Mississippi took the leading position with 179,533,000 barrels while Louisiana was second with 112,055,000. California came next with 76,925,000 and Texas was fourth with 58,103,000. During the year one state, Alabama, was added to the list of producers making twenty-six that now participate in supplying national requirements. Texas, with reserves of 11,375,480,000 barrels, has 55.6 of all United States reserves while California, Louisiana, Oklahoma, Kansas, Wyoming and New Mexico follow in the order named. These seven states, together account for 90 percent of the total reserve.

The report of the committee is as follows:

"The American Petroleum Institute's Committee on Petroleum Reserves herewith submits its report as of December 31, 1944.

"The Committee estimates that the proved reserves of crude oil in the United States, as of December 31, 1944, amounted to 20,453,231,000 barrels. This is derived as follows:





Total proved reserves as of December 31, 1943		20,064,152,000 bbl.
Extensions (new oil) and revisions during 1944	1,556,192,000 bbl.	
New reserves (new pools) discovered in 1944	511,308,000 bbl.	2,067,500,000 bbl.
Total proved reserves as of December 31, 1943 and new proved reserves added in 1944		22,131,652,000 bbl.
Subtract production during 1944		1,678,421,000 bbl.
Total proved reserves as of December 31, 1944		20,453,231,000 bbl.
Increase in reserves since December 31, 1943		389,079,000 bbl.

"The estimates in this report, as in all previous annual reports of this committee, refer solely to proved or blocked-out reserves of crude oil (including condensate) known to be recoverable under existing economic and operating conditions. Therefore, they do not include:

(1) Oil under the unproved portions of partly developed fields;
(2) Oil in untested prospects;
(3) Oil that may be present in unknown prospects in regions believed to be generally favorable;
(4) Casinghead gasoline extracted at natural gasoline plants in moderately low-pressure fields;
(5) Oil that may become available by secondary-recovery methods from fields where such methods have not yet been applied;
(6) Oil that may become available through chemical processing of natural gas;
(7) Oil that can be made from oil shale, coal, or other substitutes.

"Proved reserves are both drilled and undrilled. The proved drilled reserves in any pool include the oil estimated to be recoverable by the production systems now in operation (whether primary or secondary) and from the area actually drilled up on the spacing pattern in vogue in that pool. The proved undrilled reserves in any pool include reserves under undrilled spacing units which are so close, and so related, to the drilled units that there is every reasonable probability that they will produce when drilled.

"In the case of new discoveries, which are seldom fully developed in the first year and in fact for several years thereafter, the estimates of proved reserves necessarily represent but a part of the reserves which may ultimately be assigned to the new reservoirs discovered each year. For

Gained 389,000,000 Barrels in 1944

a one-well field, where development has not yet gone beyond the discovery well, the area assigned as proved is usually small in regions of complex geological conditions, but may be larger where the geology is relatively simple. In a sparsely drilled field the area between wells is considered to be proved only if the information regarding the geology of the field and the productive horizon is adequate to assure that such area will produce when drilled. The total of new oil through discoveries estimated as proved in any given year is comparatively small and the total of new oil through extensions is comparatively large. As knowledge of the factors affecting production and well performance become available, and as these factors are studied, reserves in older fields can be estimated with greater precision and revised accordingly. Therefore, the oil assigned to new discoveries (see Table I, Column 3), plus the oil proved through extensions (Table I, Column 2), comprises the total quantity of the new proved reserves for the year.

"The Committee again wishes especially to stress the fact that its estimates of proved reserves cannot be used as a measure of the rate at which these reserves can be produced with or without physical waste. Oil cannot be produced from the permeable rocks in which it occurs at any desired rate, because the flow of oil through the pores of the oil-bearing rocks is definitely controlled by physical factors of the reservoir. As a matter of fact, today's known oil can be recovered only over a period of many years and at gradually declining annual rates, as has been widely demonstrated by past performance under all kinds of operating conditions. For this reason those who, through arbitrary division of the known reserves by any current rate of production or by an anticipated rate of consumption, try to estimate the life of proved reserves of oil, or the rate at which these reserves can be produced, arrive at an incorrect conclusion.

"For comparative purposes we append a summary tabulation (Table II) of the overall figures contained in the committee's annual reports covering the period from 1937 to 1944, inclusive. Figures for 1935 and 1936, which were the first developed by the committee, are not available separately.

"As in the past, this committee wishes to emphasize the fact that every effort has been made to secure a fair, unprejudiced, and representative opinion. Each member in his district appointed a number of subcommittees to gather and study the necessary data. All previously determined factors pertaining to the various pools were examined and adjusted in the light of new information. The subcommittees, which were largely responsible for the data, were comprised of specially trained geologists and petroleum engineers with long experience in this class of work. We wish to acknowledge the valuable assistance and information received from these men and others and to thank for their cooperation."

The committee on petroleum reserves consists of J. Edgar Pew, Chairman, Sun Oil Co.; R. F. Baker, The Texas Co.; D. V. Carter, Magnolia Petroleum Co.; Frank R. Clark, The Ohio Oil Co.; Alexander Deussen, consulting geologist, Houston; G. Clark Gester, Standard Oil Co. of California; F. H. Lahee, Sun Oil Co.; J. M. Sands, Phillips Petroleum Co.; Fred Van Covern, American Petroleum Institute; Theron Wasson, Pure Oil Co.; Fred E. Wood, Standard Oil Co. (Indiana).

TABLE I
ESTIMATED PROVED PETROLEUM RESERVES IN THE UNITED STATES
(Barrels of 42 U. S. Gallons)

	Proved reserves as of December 31, 1943 (1)	Changes in proved reserves due to extensions (new oil)* and revisions during 1944 (2)	Proved reserves in new pools discovered in 1944** (3)	Production during 1944 (estimated) (4)	Proved reserves as of December 31, 1944 (Columns 1+2+3 less Column 4) (5)
Alabama	—	—	360,000	43,000	317,000
Arkansas	296,929,000	20,423,000	5,148,000	29,441,000	293,059,000
California	3,336,823,000	242,575,000	76,925,000	311,771,000	3,344,552,000
Colorado	45,111,000	46,025,000	647,000	2,960,000	88,823,000
Illinois	294,622,000	100,661,000	2,727,000	77,296,000	320,714,000
Indiana	31,039,000	3,887,000	1,657,000	5,090,000	31,493,000
Kansas	645,852,000	42,431,000	12,498,000	99,030,000	601,751,000
Kentucky	35,190,000	15,236,000	331,000	9,677,000	41,080,000
Louisiana	1,483,826,000	107,062,000	112,055,000	129,556,000	1,573,387,000
Michigan	55,248,000	17,745,000	10,700,000	18,559,000	65,134,000
Mississippi	38,872,000	6,973,000	179,533,000	16,367,000	209,011,000
Montana	108,057,000	11,829,000	346,000	8,582,000	111,650,000
Nebraska	1,000,000	—	—	419,000	581,000
New Mexico	653,981,000	54,101,000	2,240,000	39,556,000	562,564,000
New York	90,525,000	—	—	4,694,000	85,831,000
Ohio	32,643,000	—	1,925,000	2,944,000	31,624,000
Oklahoma	908,618,000	165,547,000	20,844,000	124,747,000	970,262,000
Pennsylvania	137,323,000	—	—	14,185,000	123,138,000
Texas	11,324,954,000	740,213,000	58,103,000	747,790,000	11,375,480,000
West Virginia	43,839,000	—	—	3,084,000	40,755,000
Wyoming	499,394,000	89,636,000	25,269,000	32,569,000	581,730,000
Miscellaneous***	306,000	50,000	—	61,000	295,000
Total United States	20,064,152,000	1,556,192,000	511,308,000	1,678,421,000	20,453,231,000

**Extensions greatly exceed revisions.*

***Only a limited area is assigned to each new discovery even though the committee may believe that eventually a much larger area will produce, for in this report we are concerned only with actually proved reserves.*

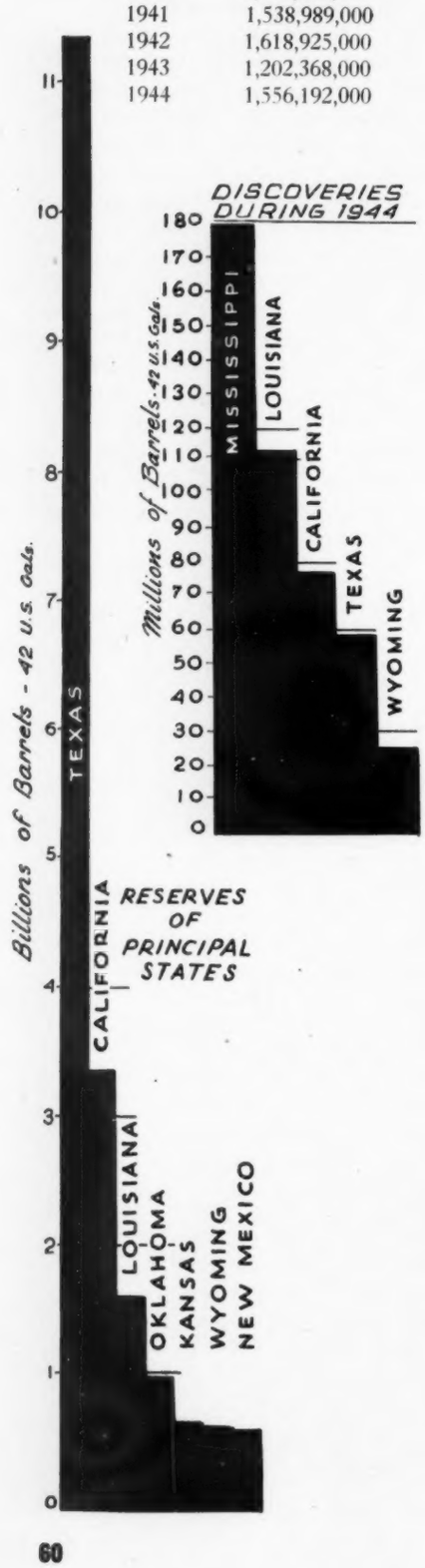
****Includes Florida, Missouri, Tennessee, Utah and Virginia.*

TABLE II

SUMMARY OF COMMITTEE'S ANNUAL REPORTS COVERING PERIOD 1937-1944

(Barrels of 42 U. S. Gallons)

Year	New Oil Blocked Out During Year: Through revisions of previous estimates and extensions to known fields	Through new pools discovered during year	Total through new discoveries, extensions and revisions	Production during year	Estimated proved reserves as of end of year
1936	----------	----------	----------	----------	13,063,400,000
1937	2,792,790,000	928,742,000	3,721,532,000	1,277,664,000	15,507,268,000
1938	2,243,571,000	810,493,000	3,054,064,000	1,213,186,000	17,348,146,000
1939	2,058,455,000	340,667,000	2,399,122,000	1,264,256,000	18,483,012,000
1940	1,607,012,000	286,338,000	1,893,350,000	1,351,847,000	19,024,515,000
1941	1,538,989,000	429,974,000	1,968,963,000	1,404,182,000	19,589,296,000
1942	1,618,925,000	260,051,000	1,878,976,000	1,385,479,000	20,082,793,000
1943	1,202,368,000	282,418,000	1,484,786,000	1,503,427,000	20,064,152,000
1944	1,556,192,000	511,308,000	2,067,500,000	1,678,421,000	20,453,231,000



WELL COMPLETIONS IN 1944

WELL completions in the United States during 1944 as compiled by the Division of Production of the Petroleum Administration for war are shown by states in the following table. According to these figures the total number of exploratory wells drilled during the year was 3881 of which 726 were productive of oil or gas. This is a percentage of successful completions of 13.5 which is very close to the average of the past ten years and does not reflect increasing difficulty in locating oil and gas.

While the number of wildcats drilled fell short of the goal set for the year by PAW total completions of all wells slightly exceeded the 24,000 proposed in the program for the year. Of the total of 24,154 wells completed, 13,127 or 54.7 percent were productive of oil and 3393 or 14 percent were completed as gas and condensate wells. This showing is considered very satisfactory under the conditions prevailing.

1944 WELL COMPLETIONS

	Exploratory**				Development***				TOTAL			
	Oil	Gas*	Dry	Total	Oil	Gas*	Dry	Total	Oil	Gas*	Dry	Total
Ala.	1	–	22	23	10	–	4	14	11	–	26	37
Ariz.	–	–	6	6	–	–	–	–	–	–	6	6
Ark.	2	2	54	58	111	25	12	148	113	27	66	206
Calif.	46	10	216	272	1624	50	100	1774	1670	60	316	2046
Colo.	2	–	12	14	27	4	14	45	29	4	26	59
Fla.	–	–	5	5	–	–	3	3	–	–	8	8
Ga.	–	–	5	5	–	–	4	4	–	–	9	9
Ill.	77	1	309	387	1181	6	451	1638	1258	7	760	2025
Ind.	13	2	80	95	150	15	78	243	163	17	158	338
Ia.	–	–	4	4	–	–	–	–	–	–	4	4
Kan.	72	14	451	537	746	73	538	1357	818	87	989	1894
Ky.	28	7	154	189	349	272	179	800	377	279	333	989
La.	27	19	120	166	391	143	188	722	418	162	308	888
My.	–	–	1	1	–	–	–	–	–	–	1	1
Mich.	18	3	231	252	235	55	154	444	253	58	385	696
Miss.	3	2	91	96	105	4	25	134	108	6	116	230
Mo.	1	3	8	12	13	4	17	34	14	7	25	46
Mont.	3	2	40	45	230	74	82	386	233	76	122	431
Nebr.	–	–	16	16	3	–	1	4	3	–	17	20
N. Mex.	5	3	45	53	259	5	49	313	264	8	94	366
NY.	–	2	11	13	845	2	7	854	845	4	18	867
N.D.	–	–	–	–	–	–	–	–	–	–	–	–
Ohio	2	21	48	71	153	526	345	1024	155	547	393	1095
Okla.	62	24	272	358	999	189	476	1664	1061	213	748	2022
Pa.	–	2	7	9	1699	796	274	2769	1699	798	281	2778
S. Dak.	–	–	–	–	–	–	–	–	–	–	–	–
Tenn.	–	–	2	2	2	1	4	7	2	1	6	9
Texas	153	50	897	1100	3327	326	1217	4870	3480	376	2114	5970
Utah	–	–	7	7	–	–	–	–	–	–	7	7
Wash.	–	–	–	–	–	–	1	1	–	–	1	1
W. Va.	–	31	13	44	83	618	136	837	83	649	149	881
Wyo.	11	2	28	41	149	5	30	184	160	7	58	225
Total U.S.	526	200	3155	3881	12691	3193	4389	20273	13217	3393	7544	24154

* Includes Condensate Wells
** Wildcats and New Pay Tests
*** Does Not Include Input Wells

Oil Company Staff Changes

EDWIN F. NELSON, head of the engineering and development department of Universal Oil Products Company, has been elected a vice-president of the company. Mr. Nelson, who is a graduate in chemical engineering of the University of Wisconsin, joined the Universal organization in 1926. Through his work as field engineer, in the research laboratories and on the pilot plants at Riverside, in the patent and engineering departments, and as assistant to J. G. Alther, executive vice-president, he learned the cracking art and technique and the operations of Universal and its licensees.

When the commercial development department was established in the early 30's, Mr. Nelson was placed at its head. In 1938 the engineering and development departments were combined under his leadership. Since before Pearl Harbor, Mr. Nelson has been wholly engaged in war work.

L. E. HANSON, assistant comptroller of the Socony-Vacuum Oil Company, Inc., has been loaned to the Reconstruction Finance Corp., Price Adjustment Board, to develop data and information required in connection with renegotiation of government contracts with the oil industry. He is the first member of the petroleum industry to be called in by the RFC to work on renegotiations.

ROBERT E. RYERSON, formerly general sales manager and recently acting head of the Eastern Division sales department of Tide Water Associated Oil Company, has been appointed a vice-president of the company. Mr. Ryerson fills the position formerly held by J. D. Collins, who died on January 20, 1945. Mr. Ryerson has had more than eighteen years' service with the company in its Eastern Division filling various positions covering both foreign and domestic sales activities.

HINES H. BAKER who has been a director of Humble Oil & Refining Company since 1937 and vice-president in charge of refining and sales since 1941 was elected to the newly created position of executive vice-president by the Board of Directors following the annual meeting of the company. A native Texan, born in 1893, and a graduate of the University of Texas, Mr. Baker joined the legal staff of Humble shortly after completing his service in World War I.

At the same time David Frame who has been a director of the company since 1941 was made vice-president in charge of production. He has been connected with the company for twenty-five years, beginning as a scout and serving successively as a divisional superintendent and more recently as general superintendent of production. He was born at Taylor, Texas, in 1890 and served overseas in World War I as a Captain of Artillery.

Hines S. Baker

David Frame

Harry W. Ferguson who was elected to the board of directors at the annual meeting will have charge of the company's refining operations. He entered the Baytown refinery in 1924 as a chemical engineer in the development division and was transferred to the Houston office in 1933 as assistant manager of technical and research work in refining. In 1937 he became a member of the manufacturing committee and since 1941 has been manager of operations on refining. Mr. Ferguson was born in Montclare, Pennsylvania, in 1902 and received his engineering degree from University of Michigan in 1924.

Carl E. Reistle Jr., who has been chief petroleum engineer for Humble since 1940, has been named general superintendent of production and will have executive charge of production activities. Born in Denver, Colorado, in 1901, Mr. Reistle received his collegiate training at the University of Oklahoma and after graduation there was a member of the staff of the Bureau of Mines for several years. Prior to joining the Humble organization, he served for three years as chairman of the East Texas Engineering Association. He is technical advisor to District 3 production committee of PIWC and a member of the executive committee of the production division of the American Petroleum Institute.

Bowman Thomas succeeds Mr. Reistle as chief petroleum engineer. He has been connected with Humble since shortly after his graduation from the University of Oklahoma in 1929 and has been assistant chief petroleum engineer since 1940.

Harry W. Ferguson

Carl E. Reistle, Jr.

George H. Hill, Jr.

GEORGE H. HILL, JR. has resigned from his position as executive vice-president and general counsel of Defense Supplies Corporation to become vice-president of Petroleum Advisers, Inc., a management and technical unit coordinating the activities of Cities Service's petroleum operating companies. Mr. Hill has been the executive director of Defense Supplies Corporation since its organization in 1942. For ten years previous to that time he served successively as attorney and counsel for Reconstruction Finance Corporation, general counsel for DSC. He is a Mississippian and received his law degree from the University of Mississippi in 1930. He had been admitted to the state bar at the age of 19, and was at that time Mississippi's youngest lawyer.

In his capacity of vice-president of Petroleum Advisers, Mr. Hill will assist President W. Alton Jones of Cities Service in connection with the company's work of supplying the government with war materials such as 100-octane gasoline, butadiene, special lubricants and ordnance. He will also aid Mr. Jones in carrying on the war activities in which he is engaged as president of War Emergency Pipelines, Inc., and in various posts in the Petroleum Administration for War and Petroleum Industry War Council. Mr. Hill will also devote time to the company's program of postwar rehabilitation and extension of plants.

WILLIAM F. THIEDE has been appointed manager of the New Jersey Works of Standard Oil Company of New Jersey which includes refineries at Bayway, Bayonne, and the Eagle Works in Jersey City. He succeeds the late G. H. Mettam. Mr. Theide has been with the company nearly 33 years, starting as an errand boy in 1909 during school vacations. He was made assistant superintendent in 1936 and was transferred two years later to the Bayonne refinery as acting general superintendent, later becoming general superintendent. He was made assistant manager of the New Jersey Works in 1944.

DR. FRANK M. SURFACE has been appointed executive assistant to the president of Standard Oil Company (New Jersey). He has been coordinator of sales research for the company since 1943. Prior to that time he was, for ten years, director of sales research for its domestic operating subsidiary, Standard Oil Company of New Jersey. An authority on economics and author of many articles and books on the subject, he was formerly assistant director of the Bureau of Foreign and Domestic Commerce in the Department of Commerce from 1927 to 1933.

Born in Eaton, Ohio, Dr. Surface attended Ohio State University and the University of Pennsylvania where he received his doctorate. After several years' study in biological research work at various universities, he became assistant chief of the statistical division of the U. S. Food Administration during World War I. He served as food statistician with the American Peace Commission in Paris after the war, and as chief statistician for the American Relief Administration in Europe.

He returned to Washington in 1921 as special agent for the Bureau of Census, founded and edited the Department of Commerce publication, "Survey of Current Business"; and became assistant director of the Bureau of Foreign and Domestic Commerce in 1927. He was visiting professor of marketing at Stanford University Graduate School of Business in 1929-30.

ARTHUR T. PROUDFIT has been elected president of the Creole Petroleum Corporation to succeed C. H. Lieb who died in December. Mr. Proudfit had been a vice president and general manager of the company's Venezuelan operations and will continue as general manager with his office in Caracas.

Horry F. Prioleau was elected executive vice president and becomes Creole's chief executive officer in New York. Mr. Prioleau has been vice president and is a director.

Both these new officers have had more than twenty years' experience in the petroleum industry, largely in foreign operations. Mr. Proudfit started in 1919 as a drilling tool dresser for Huasteca Petroleum Company in Mexico. Mr. Prioleau began as a laboratory assistant in the Charleston, S. C., refinery of the Standard Oil Company of New Jersey in 1921.

Mr. Proudfit had risen to full charge of all drilling operations of Huasteca when he left Mexico in 1927 to become assistant superintendent of operations of Lago Petroleum Corporation in the Lake Maracaibo fields in Venezuela. In January, 1936, he joined the Standard Oil Company of Argentina as manager of its northern division. Late in 1938 he returned to Venezuela as assistant manager of Standard Oil Company of Venezuela. A few months later he was made manager and, in 1942, was elected president of Standard of Venezuela. When that company and Lago were consolidated with Creole in 1943 he became a vice president of Creole and general manager of all operations in Venezuela.

Mr. Prioleau worked at Charleston refinery until 1925, when he came to New York as assistant to its general manager. His work was subsequently broadened to include Latin-American and other foreign refineries. In 1929 he went to The Hague as head of the refinery department of N. V. Nederlandsche Koloniale Petroleum Mij., a New Jersey Standard affiliate. He became general manager of NKPM in 1934 and continued at The Hague until forced out in 1940 by German occupation of Holland. He returned to New York in August, 1940, where he was connected with various foreign operating units of the Jersey Standard group until when he joined the staff of Creole as an assistant to the president. Mr. Prioleau was elected a vice president and director of Creole in 1944.

Arthur T. Proudfit

Horry F. Prioleau

The ancient alchemist attempted to change base metals to gold

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CATALYTIC REFORMING	*THERMAL REFORMING*	*POLYTREATING*
HYDROGENATION	*HYDROFORMING*	*U. O. P. CATALYSTS*
ALKYLATION	*DEHYDROGENATION*	*UNISOL TREATING*
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For All Refiners

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Burl J. Watson

Harold Decker

Dr. H. D. Wilde

SEVERAL changes and promotions in the official family of Cities Service Company have been announced by W. Alton Jones, president. Burl S. Watson, a director of the company since 1940, has been elected a vice-president; Ernest H. Johnston becomes treasurer; Erle G. Christian, comptroller, has been named secretary of the company, and Chester E. Weger will succeed Mr. Christian as comptroller.

Mr. Watson has been in the employ of Cities Service Company, except for time spent in the U. S. Army, since he graduated from the University of Alabama in 1917 with the degree of electrical engineer. He came to New York in the early 20's and was made assistant to W. Alton Jones in 1930. He became president of Sixty Wall Tower, Inc., and was largely responsible for the construction of the world's third tallest building, in which Cities Service makes its headquarters.

In 1940 he was made assistant to Temple W. Tutwiler, president of Petroleum Advisers, Inc., a management and technical group coordinating with activities of Cities Service's various petroleum operating companies. He was made executive vice-president of the petroleum, natural gas and electric utility subsidiaries, and is in general charge of Cities Service's reality holdings in lower Manhattan.

Mr. Johnston,a graduate of the University of Illinois in 1907, has been with the Cities Service organization for 38 years, and a member of its board of directors since 1916.

The new secretary, Mr. Christian, joined the company in 1914 as a meter reader for one of its electric subsidiaries. He was made comptroller in 1939. Mr. Weger, who succeeds him, is a University of Michigan graduate, and has been with Cities Service since 1916. He was made a manager of the budget department in 1924 and treasurer of Petroleum Advisers, Inc., in 1938.

HAROLD DECKER, formerly of Corpus Christi, has joined the Pan American companies in Houston as assistant manager of the Pan American Production, Pipe Line and Gas Companies and as such will serve as first assistant to E. R. Turner, vice president and general manager. Mr. Decker was born in Chicago in 1903. He attended Kenyon College and the University of Oklahoma, majoring in petroleum engineering. On completion of his college work in June, 1925, he was employed by the Rio Bravo Oil Company, leaving them a year later to do engineering work for the Marland Oil Company. In 1929 and 1930, he was with the Tidal Oil Company and was then employed by the Skelly Oil Company as petroleum engineer and subsequently as division superintendent at Houston. In 1937 he joined the Seaboard Oil Company as district superintendent for the Coastal and Southwest Texas area in charge of production, land and geology.

R. M. GRAY, advertising and sales-promotion manager of the Standard Oil Company of New Jersey and affiliated companies, was recently elected a director and vice president of Esso Incorporated.

DR. H. D. WILDE, manager of the Technical and Research Division of Humble Oil & Refining Company's refining department since 1933, was appointed last month to the newly created post of manager of research and development for the company, according to an announcement by Humble officials.

In the new assignment Dr. Wilde has general supervision and coordination of the work of three distinct groups serving the principal departments of the company: the Technical and Research division of the refining department which carries on technical service, control testing, research and development work at the refineries; the Geophysics Research division of the geologic, land and lease department which carries on research and development work connected with geophysics exploration, including the search for new methods of exploration; the Production Research division of the production department which carries on research and development in two major fields, geochemical exploration which involves the search for and discovery of oil deposits by chemical analysis and production which covers well spacing, rate of production, oil and gas ratio, water encroachment, mud logging and related subjects.

Dr. Wilde, whose employment with the company dates back to 1927, was born in Aguascalientes, Mexico, in 1900. He received his primary training in a mission school in Monterrey, and his high school education in Ypsilanti, Michigan, and San Antonio.

In 1917 he entered the University of Texas and received his Bachelor's degree in Chemical Engineering in 1923 and the Master's degree the following year. For three years following his graduation, he attended Massachusetts Institute of Technology working toward his Doctor's degree and doing part-time work on the staff of the Research Laboratory in applied chemistry.

Late in 1926 he came to Baytown refinery to gather data for his Doctor's thesis, which involved a study of plate efficiency in commercial petroleum fractionating towers. He began his employment in the Technical and Research division at Baytown the following year and in 1929 was called to Houston to head a new group to carry on production research. He remained in this capacity until 1933, when he became head of the Refining department's Technical and Research division. The work of Dr. Wilde and his associates prior to and during the present war has played a prominent part in placing the company in a leading position in the war production program.

(*Continued on page* 74)

CLARK VERSATILITY

WHEN the Army needed a small, extremely lightweight, nonlubricated, high-speed compressor, Clark undertook to design and build it. The speed required (1800 rpm) seemed at first to be beyond the practical limit, but like so many things that look impossible, "it had to be done and we did it".

We are not permitted to tell what this small compressor is used for, but it has proved highly successful. In contrast with one of our well-known standard models—a 3-cylinder gas engine driven "Angle" compressor—this little fellow looks and is a mere midget. But its 75 B.H.P. and 225 C.F.M. capacity are 25 per cent as great as its big brother's, over fifteen times its weight.

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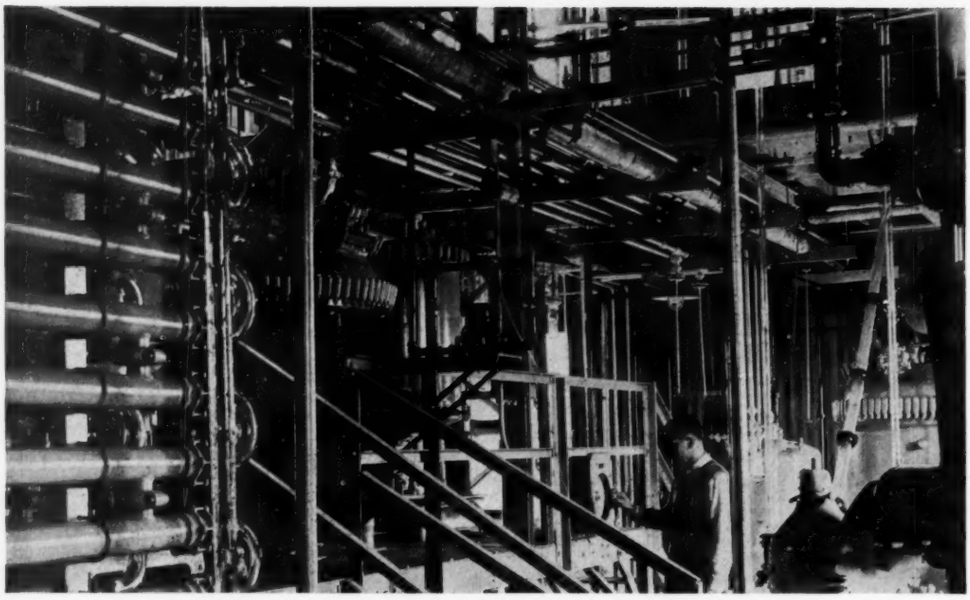

Interior Rubber Polymerization Pilot Plant

Rubber Polymerization Pilot Plant

PHILLIPS PETROLEUM COMPANY has recently announced the completion of an extensive rubber polymerization plant at Phillips, Texas. The new unit constitutes another addition to centralized research department facilities, which were shown to the public during an open house in January.

Experimental studies related to the production of better quality polymers are now being conducted by a staff of chemists and chemical engineers, under the supervision of J. E. Troyan, who was recently associated with the process development section of the Office of Rubber Director.

The pilot plant contains diversified equipment for distillation and purification of monomers, polymerizers, a coagulation unit, and filtration and drying equipment. Here it will be possible to produce sufficient rubber for full-scale processing and tire tests. Auxiliary refrigeration equipment, a small scale polymerization unit and raw material storage space are located in an adjacent one-story building.

A distinctive feature of the Phillips pilot plant design is the use of glass-lined vessels and Pyrex piping at all points in the process where it is desired to prevent contamination of the latex and chemicals handled.

Levorsen Joins Stanford Faculty

A. E. LEVORSEN, independent research geologist of Tulsa, Okla., and past president of the American Association of Petroleum Geologists, has been appointed professor and executive head of the department of geology at Stanford University. He will take up his duties at the beginning of the autumn quarter in September.

After graduation from the University of Minnesota in 1917, Mr. Levorsen served as geologist for several oil companies and was chief geologist for Tide Water before establishing himself as a consultant in 1936.

A member of the National Research Council, Mr. Levorsen also is a councilor of the Geological Society of America and the Society of Economic Geologists. For the past seven years he has been chairman of the research committee of the American Association of Petroleum Geologists and was president of that group in 1935.

Mr. Levorsen is the author or editor of numerous technical studies dealing with petroleum geology, structural geology, and stratigraphy. During the past few years, he has been a visiting lecturer on geology at major universities throughout the United States.

Aruba's Billionth Barrel

BROKEN records in production have been plentiful during the war but one that is particularly impressive was celebrated at Aruba on March 15. The occasion was the processing of the billionth barrel of crude at the refinery of Lago Oil & Transport Co., subsidiary of Standard Oil Company (N. J.). The record is the more remarkable in view of the fact that Aruba has been in operation only sixteen years so that its average throughput during all that time has been over 170,000 barrels. Of course, it was much smaller in the beginning and is far greater now for the plant has been enlarged in the past few years to become one of the greatest in the world.

The management and employees of Lago received many messages of congratulation on their achievement including cablegrams from Admiral Carter of the U. S. Navy, Lieut. Gen. Barney M. Giles, chief of the Air Staff, Petroleum Administrator Ickes and Robert P. Patterson, Under Secretary of War.

In his message Secretary Ickes said:

"This is an outstanding record, achieved despite adverse conditions, extended black-outs, and even enemy attack. Every gallon of product from your plant since before Pearl Harbor has represented a direct contribution toward winning the war and every member of your organization who has borne a part may take pride and satisfaction in the accomplishment. The military forces today need every additional gallon of war products that can be produced and I know that we may count upon continued all-out performance at Aruba."

W. H. Smith Joins Hunt Tool

HUNT TOOL COMPANY announces the appointment of W. H. Smith as assistant sales manager. He comes to Houston from Casper, Wyoming, where he has represented Reed Roller Bit Company as division manager for the past six years. Smith has been a member of the Reed sales department since graduation from the University of Texas in 1934. In his new connection with Hunt he again serves under W. J. "Bill" Nutto who resigned as sales manager of Reed in 1944 to become vice president and sales manager of Hunt Tool Company.

Company Changes Name

WEST INDIA OIL COMPANY (Puerto Rico), affiliate of Standard Oil Company (New Jersey), will hereafter be known as Standard Oil Company of Puerto Rico. The change does not affect the company's corporate structure of operating methods. Guy Warner, president since 1935, continues in that capacity.

Smith Establishes Export Office

ELMER R. SMITH, formerly in charge of foreign activities for Lane-Wells Company, is now specializing in export representation for a group of oil equipment manufacturers. With offices in the Oviatt Building, Los Angeles, he is now representing in foreign fields the following companies: H. C. Smith Oil Tools Company, MacClatchie Manufacturing Company, Burns Tool Company and Plastik Company of America. Mr. Smith was with Lane-Wells Company for eleven years, the last six in export work. Before that he was with Martin-Decker Corporation for three years and with Shell and Richfield for three years. Mr. Smith will make a trip to South American countries in the very near future.

DESPITE *given crude sources* and *established markets*... refinery managements and their engineering staffs do not have a simple task in reaching decisions on postwar remodernization plans.

After due study of process recommendations and proposed capital investments . . . ticklish questions remain to plague. Is the plan sufficiently elastic to provide for envisioned product improvements? Does it provide the shortest pay-off period? Will current equipment be utilized to the fullest advantage?

It is here that the full scope of M. W. Kellogg's complete service is most appreciated—and valued—by customers. For this service embraces more than that of designer-builder. It shoulders the direct responsibility to the refiner of translating plant operations into maximum profits.

Supplementing and integrating the customer's management and engineering staff planning... Kellogg brings the full weight of its process design, pilot plant data, diversified outside commercial experience, and economic consultation services to bear on the specific problem involved.

Invariably, with increased profits as the goal, not one but several solutions present themselves. But for *maximum* profits . . . there is only *one!* For instance, in a recent case study, exhaustive analysis disclosed three different potentially profitable solutions.

Case A showed a 205% increase over existing yearly net credit... with a pay-out period for remodernization of 3.84 years—amortizing capital investment exclusively from the *increase* in annual credit.

Case B, on the other hand, showed an increase in yearly net credit of 263% (a further increase of 58%). In addition, it provided a shorter pay-out period—3.39 years—notwithstanding a 13% greater increase in capital expenditure.

Case C offered the same fundamental advantages as B . . . with a different choice of by-products.

Such detailed explorations of a client's problems demonstrate the responsibilities that M. W. Kellogg assumes over and above those of mere designer-builder. May we consult with you on your current plans?

THE M. W. KELLOGG COMPANY

Engineers and Economists to the Petroleum Refining Industry

★Only Kellogg Service Has Them All

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WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing with Technical and Economic Aspects of the Petroleum Industry—Edited by Dr. O. W. Willcox.

NATURAL GAS

Overcoming Bad Effects of Water on Gas Sands—K. J. Sonney and Charles E. Williams in OIL WEEKLY, Vol. 113 (1944) No. 12, pp. 18, 20, 22, 24, 25.

Sometimes, by accident or design, the face of the sand in a gas well comes into contact with water which fills the pores in the sand immediately around the well, and may "kill" the well by preventing the gas from coming through, especially if the formation pressure is rather low. Theoretically, the water penetrates the sand evenly in all directions in a ring, the center of which is the well. By injecting gas under pressure the water may be pushed back into the sand and the ring will diminish in thickness, and if pushed back far enough it will eventually break and leave channels for the gas to come through. Water, as is know, has a tendency to wet the sand grains, and on account of its relatively high surface tension, will oppose both the entry of the gas into the formation and its backward movement when the pressure that drove in the gas is released.

The idea involved in this work is that if the water in the sand were first diluted with alcohol or acetone, its surface tension will be reduced and the regeneration of the killed well by the gas injection method would be easier. As an experiment a small well that before flooding had been producing 3500 cu. ft. was treated with 244 gallons of acetone, which was pumped into the sand, and the flow was thereby increased from 500 to 2400 cu. ft. In another case a well that had an open flow of 380,000 cu. ft. a day and a rock pressure of 655 lbs. was killed in order to make repairs; enough acetone was lubricated into the hole, and after cleaning out came back with an open flow of 346,000 cu. ft., a decrease of only nine percent from the flow before killing. Other examples and operating procedures are given and it is concluded that there is a wider field for the application of this process.

Underground Storage of Natural Gas.–E. G. Dahlgren, before AMERICAN PETROLEUM INSTITUTE, Production Division, Columbus Meeting, April 1944.

This is a third report on the use of depleted or near depleted oil and gas reservoirs for the storage and conservation of natural gas, presented in behalf of the Research and Coordinating Committee of the Interstate Oil Compact Commission.

It is again insisted that the importance of underground gas storage in the war effort cannot be minimized. The vital industrial areas of the Cleveland-Pittsburgh-Wheeling region obtain part of their gas supply from that source. Peak demands might not have been met if gas stored underground had not been available for use. The same situation prevails in the industrial area about Kansas City.

From the conservation standpoint underground storage is beneficial in enabling the transfer of gas into storage from highly competitive areas where flush production might encourage uneconomical use of the product on account of a need for an immediate market. Underground storage is beneficial to the small stripper gas wells, especially in the Appalachian Area, which can be only operated economically if they are used every day. When domestic markets are curtailed in the summer months, these wells would be shut in if underground storage was not utilized. The abandonment of many of these wells has been avoided because they can now be produced with at least a small profit by using them daily.

According to the Bureau of Mines 1942 Minerals Yearbook, Natural Gas Chapter, approximately 15 billion cubic feet were stored underground in 1940, while approximately 16¼ billion cubic feet were stored in 1941. It is estimated that almost 19 billion cubic feet were stored in 1942 and over 8 billion cubic feet in 1939. It is estimated that some 50 or more projects are in operation with a storage capacity of 135 billion cu. ft. and with delivering capacity of 750 million cu. ft. a day.

The author presents recent information on underground natural gas storage installations throughout the United States and Canada. Descriptive details are given on projects in Arkansas, California, Kansas, Kentucky, Michigan, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Texas, West Virginia, and Alberta, Canada.

PETROLEUM ENGINEERING

Determining Water Input Profile.—E. J. Pfister and R. L. McCormick. Presented at 8th Technical Conference on Petroleum Production, SCHOOL OF MINERAL INDUSTRIES, PENNSYLVANIA STATE COLLEGE—1944.

In the secondary recovery of oil by water flooding, there has been a need for a method to measure the water injected into each stratum of sand.

In practice the less permeable sands are now heavily shot with nitroglycerin in order to equalize the water intake between permeable and impermeable sands. The extent to which such corrective shooting is successful has been a subject of much conjecture because no direct measurement has been available for determining the water intake of the individual sands as they exist in the well. In many cases the permeable sections of sand take so much water even without shooting that certain loose strata of sand produce their oil and become watered out long before the tighter sands produce much of their available oil. This bypassing of water through the loose strata of sand, while the tight sands are still productive often makes the continued operation of a block of wells uneconomical because too much water must be handled for the amount of oil produced. To correct this situation it is desirable to plug the loose sands selectively, thus shutting off, or greatly reducing, the amount of water entering these strata. However, since no method of measurement of the water in-put in each stratum of sand has previously been available no direct evaluation of the selectivity of a selective plugging agent was possible.

A unique way of measuring the water input profile has been devised in which brine and fresh water are separately introduced in the well and a sharp boundary set up between the two.

The brine is introduced at the bottom of the well through ¾-in. tubing and the water is injected in the annulus between the regular well tubing and the ¾-in. tubing. A probe or contactor electrode has been devised by which the sharpened brine boundary can be located accurately. For this, an electric current is carried down an insulated cable to an electrode, which forms a contact to ground through the well fluid at the sand depth. The contact is fromed through brass lugs placed on the insulated plastic section placed opposite the production formations. Thus, the well fluid outside the pipe in the immediate vicinity of the electrode determines the amount of current flowing to ground.

By measuring the brine and water rates into the well while the boundary is held stationary, the amounts of fluid entering the sands above and below the boundry are known. Raising the position of the bundary 1 ft. and repeating the measurements gives by difference the amount of fluid entering this 1-ft. section of sand.

BOOK

The Technique of the Terrain, by H. A. Musham; published 1944 by Reinhold Publishing Corp., New York; 228 pages, $3.85.

This book is intended as a text on maps and their uses in war and peace. It deals largely with the use of maps in military operations where a thorough appreciation of the terrain is essential to a true understanding of war. It is no less true that a thorough understanding of maps is essential to civilians who have to do with topography, in particular, oil prospectors and petroleum geologists. The principles of map making and map construction are explained with a minimum of mathematics.

Review of Petroleum Geology in 1943, by F. M. Van Tuyl. Published 1944 as No. 2, Vol. 39 of QUARTERLY OF THE COLORADO SCHOOL OF MINES, paper, 127 pages, $1.00.

The information presented in this book has been assembled from the literature and from a canvass of leading workers in exploration geophysics, petroleum geology, and the border-line field having to do with the geologic and geophysical aspects of petroleum-production engineering. A summary discussion of the noteworthy events of 1943 includes news items of the profession; the influence of the war on petroleum geology; contributions of geologists and geophysicists to the war effort; important meetings, conferences, and symposia; and significant investigations completed or in progress.

Under the heading of advances in petroleum geology are considered new concepts, new developments and trends in education, new maps and publications of general interest, important developments in basic geologic sciences, contributions to fundamentals of petroleum geology, developments in petroleum geophysics, progress in geochemistry and geobiology, developments in geologic phases of petroleum engineering, and advances in the applications of aerial photography. New and improved techniques in the fields of spectroscopy, fluorescence, and microscopy also received attention. Noteworthy discoveries of new geologic or geophysical conditions, of new petroliferous provinces, of important deeper "pay" horizons both in this country and abroad are reviewed and an effort is made to evaluate their influence in the field of petroleum geology.

PHYSICS

Optical Rotation of Pennsylvania Lubricants—F. L. Carnahan, R. E. Hersh and M. R. Fenske in INDUSTRIAL ENGINEERING CHEMISTRY—Vol. 36 (1944) No. 4, pp. 332-335.

In a search of methods for identification of lubricating oils with respect to geographical origin the optical rotations of petroleum fractions were investigated. It appears that the maximum rotatory power in a mineral oil is commonly associated with those portions having a molecular weight of about 400; such material is usually distilled in the refining process and is included in the neutral. The low rotatory power of Pennsylvania oil fractions is of interest. The present paper gives the application of these observations to the identification problem with particular reference to the detection of non-Pennsylvania material. However, the general procedure should be of value in the tracing or recognition of various mineral oil products because of the dependency of rotatory power upon crude source and on account of its persistence.

Optical rotations have been found on distillate fractions from seventy-six commercially refined Pennsylvania oils and in most cases a reading has also been made on the original oil. The group includes one or more neutrals from each known Pennsylvania refiner; it is in this volatility range that optical activity reaches its maximum. The highest rotation noted for any fraction was +0.26. Accordingly, it appears that higher values obtained in an equivalent procedure indicate a crude source other than Pennsylvania. Included also are certain supplementary data on neutral oils prepared from individual well samples of crudes from various geographical sources.

Torque-Viscosity Characteristics of Lubricating Greases—L. C. Brunstrum, E. W. Adams and E. E. Ziegler (Standard Oil Co. Indiana) before NATIONAL LUBRICATING GREASES INSTITUTE, 12th Ann. Meeting, October, 1944.

Although many varieties of torque tests have been used to evaluate lubricants, the subject warrants especial attention at this time because of the present widespread interest in the properties and behavior of greases in relatively slow moving bearings at temperatures as low as minus 100°F. The conventional function of torque determinations at low temperatures is either the empirical evaluation of lubricants under a given set of mechanical and atmospheric conditions or the determination of the most drastic conditions under which a given lubricant will give satisfactory service. However, if improvement of the lubricants is to continue the tests must be related to the more fundament properties of the products.

Two torque methods are commonly used, (1) the constant torque-variable shear method in which a given load is applied and the resulting speed measured and (2) the constant speed-variable torque tchnique in which the bearing is driven at constant speed and the resulting force is measured on the other race. From a mechanical point of view the results by these methods should be identical. However, because of the peculiarities of lubricating grease consistency (apparent viscosity), the results are not comparable unless certain precautions are taken.

To obtain a direct comparison of results by the two methods a tester was built which is capable of being operated at either constant torque or at constant shear rate. Conversion is accomplished by a simply changing the drive, i.e., by using weights or a motor. Three bearings mounted on a horizontal shaft are used to minimize slight variations in bearing fits and grease packing.

The conclusions are as follows:

1. The torque value of any grease at a given temperature (above its plasticity point) is any value from some high figure (depending on soap content) to almost the viscosity of its oil and depends on the share rate of the test.

2. Torque values obtained in a 204 bearing at 2 rpm and converted to viscosity have about the same temperature-viscosity slope as pressure viscosity lines and appear to be equivalent to the shear rate range of 200 to 700 reciprocal seconds.

3. Grease viscosity has a smaller temperature coefficient than that of the oil in the grease even when both are considered in the same viscosity range. This is obviously not true in the extremely low temperature range where grease viscosity and oil viscosity are parallel.

In general, it is thought that torque in a given bearing is proportional for the most part to grease viscosity at the shear rate in use, subject to deviations that should be used to explain the action of the grease in the bearing.

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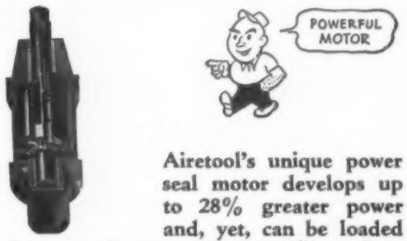

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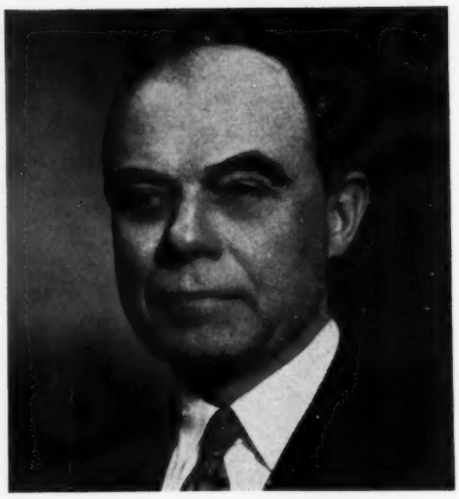

Ernest P. Schroeder

ERNEST P. SCHROEDER has been made manager of the foreign engineering department of the Westinghouse Electric and Manufacturing Company and John T. Mathews has been named assistant manager. Mr. Schroeder succeeds D. I. Vinogradoff, who has been transferred to Westinghouse International on special assignment.

Mr. Schroeder was born in South Africa, received his schooling there and in 1906 received an electrical engineering degree from the Polytechnikum Mittweida in Germany. He was affiliated with the Siemens in Germany and South Africa from 1906 to 1915. He came to the United States in 1916 and in the following year joined the Westinghouse organization.

Mr. Mathews, formerly engineering representative of Westinghouse International in Argentina, was born in St. John, New Brunswick, Canada, and received his engineering degree in 1927 from the University of British Colombia. He joined Westinghouse in 1927 and was assigned to engineering development work until 1934 when he joined the foreign engineering department as liaison engineer in France and Germany. Since 1940 he has been in England and Argentina for the International company.

DR. PAUL HUGH EMMETT, a chemist who has distinguished himself by his researches on catalysis, has been added to the investigational staff of Melon Institute. Born in Portland, Ore., Dr. Emmett studied chemical engineering at Oregon State College and followed with graduate work at California Institute of Technology leading to a Ph.D. in 1925. He engaged in studies on catalysis at the Fixed Nitrogen Laboratory of the U. S. Department of Agriculture in Washington from 1926 to 1937. From 1937 until his appointment at Mellon Institute he was professor of chemical and gas engineering at Johns Hopkins University and also consultant of the U. S. Department of Agriculture. Recently he has been active in wartime research for the government, on leave of absence from Johns Hopkins.

At Mellon Institute Dr. Emmett will plan and supervise long-range investigational projects on catalysis of importance in petroleum technology.

THOMAS A. O'DONNELL who died in a Los Angeles hospital on February 22 at the age of 74, was among the pioneers in the development of the California oil industry with which he had been prominently associated for more than forty years. He was born in western Pennsylvania and began to earn his own living at an early age, working his way westward until he reached the Pacific Coast in 1888 when he was eighteen. There he entered the employ of Charles A. Canfield and Edward A. Doheny, became a field superintendent and drilled the first oil wells in Los Angeles.

When the American Petroleum Company was organized in 1907, Mr. O'Donnell was made vice president and manager. He served in a similar capacity in other companies which subsequently were merged in the California Petroleum Company of which he became president and later chairman retaining his connection until the company was purchased by The Texas Company. For many years Mr. O'Donnell, E. L. Doheney, Charles A. Canfield and Max Whittier were known as the Big Four of the California industry.

In the national field one of Mr. O'Donnell's conspicuous services was the active part he played in founding the American Petroleum Institute. During World War I he was a member of the national committee that directed the supply and transportation of oil for military use. The work of this committee led to the organization of the American Petroleum Institute in 1919 at the end of the war and Mr. O'Donnell was elected as its first president, serving until 1924.

Thomas A. O'Donnell

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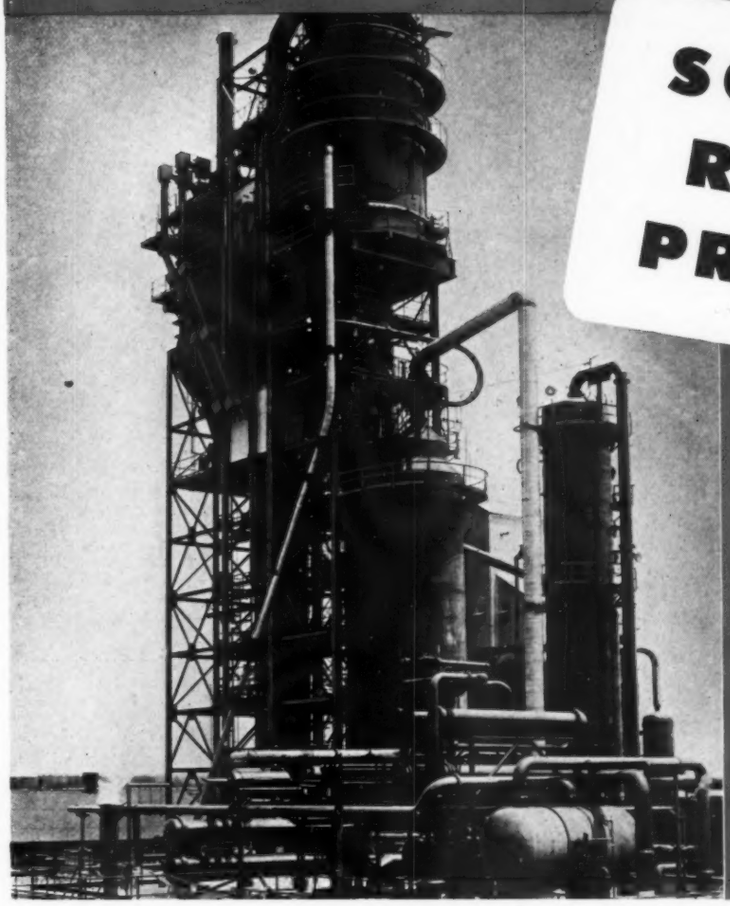

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OIL COMPANY STAFF CHANGES

(*Continued from page* 64)

DONALD L. FERGUSON, general superintendent of the Bayway refinery, has been appointed assistant manager of New Jersey refineries of Standard Oil Company of New Jersey. Richard J. Kaul, assistant to the general manager of East Coast manufacturing operations, succeeds Mr. Ferguson as general superintendent of Bayway refinery. J. Raymond Eiffe has been appointed assistant general superintendent and process superintendent at Bayway, and Bryant F. Kenney has been transferred to the New York offices of the company as assistant to the general manager of East Coast operations. Willard F. Wadt has been appointed acting process assistant to the manager of the New Jersey Works; Charles E. Borgstrand has been made acting process superintendent at Bayonne; and Francis J. Powers, assistant process superintendent at Bayonne, assumes the additional responsibility as head of process control.

H. G. DENHAM has been appointed manager of sales for the Arabian American Oil Company. Although the headquarters of the company, jointly owned affiliate of California Standard and Texas, is in San Francisco, the new manager will spend much of his time in the New York office.

A graduate of Brown University, Denham joined California Standard in 1927 after serving in the oil distribution business in China for 11 years, where he worked for Socony-Vacuum. He became assistant manager of Standard's foreign trade department and in 1943 was named president of the California Commercial Company, a Standard subsidiary.

KENNETH C. HEALD, chief geologist, and Dr. Paul D. Foote, executive vice president of Gulf Research and Development Corporation, have been elected vice presidents of Gulf Oil Corporation. Dr. Foote is a graduate of Western Reserve University and has specialized in the field of physics. For some years he was associate physicist to the Bureau of Standards. He joined the Gulf research organization in 1927. Mr. Heald received his university training at Yale. For several years he was attached to the U. S. Geological Survey, leaving there in 1924 to become professor of petroleum geology at Sheffield Scientific School. He entered the employ of Gulf as staff geologist in 1929.

MILTON N. WEIR, formerly assistant division manager of the New York Division of the Gulf Oil Corporation, who has been made assistant to W. V. Hartmann, vice-president in charge of sales of the company. Mr. Weir will have his headquarters in New York.

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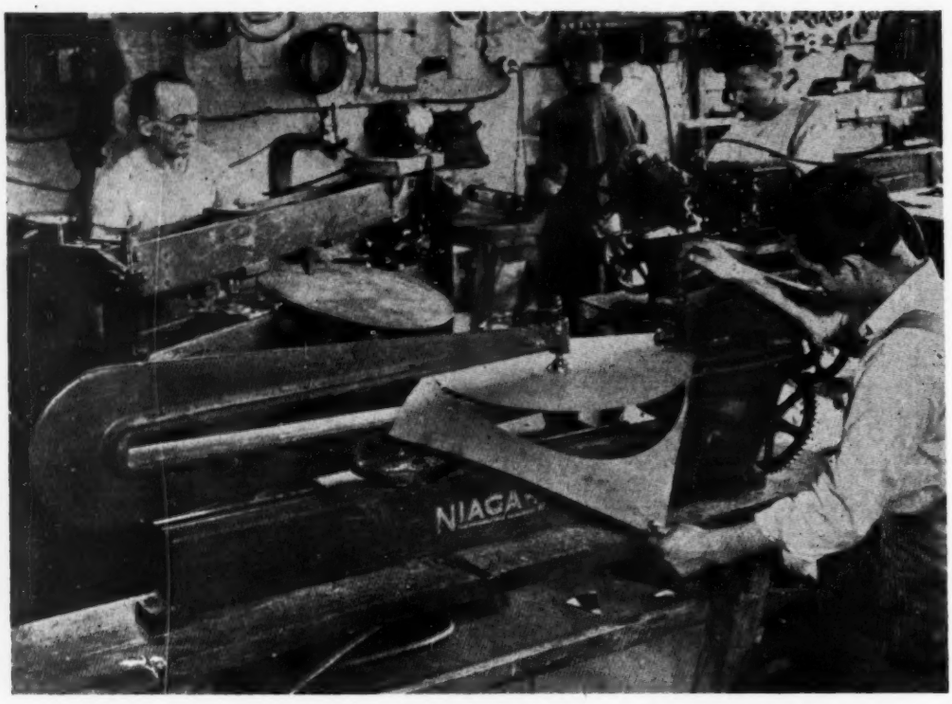

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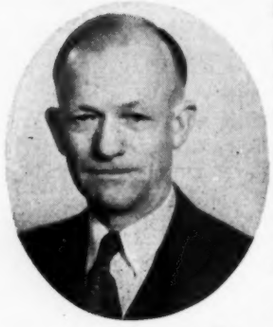

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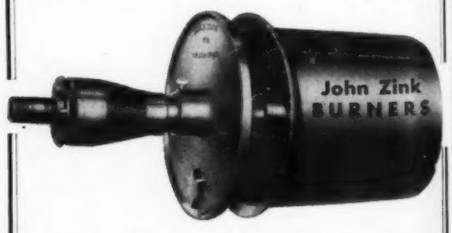

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New York Chapter of Nomads—1945 Officers, Standing Left to Right: C. R. Tunnell, treasurer; E. L. Carter, asst. treasurer; W. H. Siems, regent; H. J. McAdams, sergeant at arms; G. V. Leece, asst. sergeant at arms; J. W. Reed, asst. secretary — Sitting Left to Right: R. M. Dinges, secretary; E. H. Trammell, president; W. G. Foster, vice president. W. J. Campbell, regent, was not present at the time this photograph was made.

THE monthly meeting of the New York Chapter of Nomads was one of the most successful in the Chapter's history with an attendance of over 200 members and guests, including many visitors from South America and other foreign fields. The entertainment committee sprang a surprise by presenting a South American "expert" who had many of the oil men sitting on the edge of their chairs with the dire picture he painted as to what was to happen to their concessions, but the tension was released when the imposture was revealed. Anticipating an influx of foreign visitors with the resumption of export activity the Nomads are planning a series of entertaining meetings during the year.

WALTER K. LINK has taken up his new duties as exploration manager and chief geologist for Tropical Oil Co. in Colombia, where a large exploratory program is now underway. Mr. Link came to Colombia for the first time some 18 years ago and surveyed in particular the oil possibilities of the Llanos region, the vast plains located on the east flank of the Andes. This was in connection with geological work which Standard Oil Company (N. J.) was then carrying both in Colombia and Venezuela. Later he went to the Dutch East Indies and in 1935 returned to the United States where he was engaged by the Carter Oil Co. in operations in the Mid-continent. In 1937 he was appointed manager of the Exploration Department of the Standard Oil Co. of Louisiana., a post which he discharged until 1940. In that year Mr. Link took over exploration operations in the West Indies, Central America and the non-producing countries of northern South America working directly under Jersey's New York office. In February 1945 he accepted his position with the Tropical Oil Co. with Bogota as headquarters.

Los Angeles Chapter of Nomads—1945 Officers Left to Right: Sitting—Roland E. Smith, regent; Elmer R. Smith, president; Henry W. Pullman, regent — Standing Left to Right: Custer Morrow, deputy sergeant at arms; Jim Robinson, secretary; C. M. Byron, asst. secretary; Waldo Moore, asst. treasurer; Hi Cassidy, sergeant at arms; Fred Tyler, treasurer; Bill McGraw, vice president.

ADERTISERS' INDEX

Airetool Mfg. Co. ---- 71
American Locomotive Co. ---- 29
Attapulgus Clay Co. ---- 3
Axelson Mfg. Co. ---- 80
Baroid Sales Div. ----Inside Back Cover
J. B. Beaird Companyy ---- 15
Bechtel-McCone Corp. ----Facing Page 48
California Texas Oil Co. ---- 20
Caterpillar Tractor Co. ---- 17
Chemical Construction Co. ---- 72
Chicago Bridge & Iron Co. ---- 23
Clark Bros. Co., Inc. ---- 65
Clark Bros. Co., Inc., (Slush Pump Div.) ---- 13
Crane Co. ---- 22
Foster Wheeler Corp. ----Facing Page 17
Gaso. Pump & Burner Mfg. Co. ---- 27
General American Transportation Corp. ---- 18-19
General Chemical Co. ---- 9
Graver Tank & Mfg. Co., Inc. ---- 32
The Griscom-Russell Co. ---- 14
The Guiberson Corp. ---- 8
Joshua Hendy Iron Works ---- 4
Houdry Process Corp. ---- 24
The M. W. Kellogg Company ----68-69
Kerotest Mfg. Co. ---- 7
Ladish Drop Forge Co. ----Facing page 8
Leyman Mfg. Corp. ---- 67
Lummus Co. ----Facing Page 33
Arthur G. McKee & Co. ---- 73
Merco-Nordstrom Valve Co. ---- 31
Lee C. Moore & Co., Inc. ---- 76
North American Geophysical Co. ---- 21
Odenbach Shipbuilding Corp. ---- 79
Patterson Ballagh Corp. ----Facing Page 49
Petroleum Rectifying Co. of Calif. ---- 12
Wm. Powell Co. ---- 11
Security Engineering Co., Inc. ---- 75
Sinclair Refining Co. ---- 10
Socony-Vacuum Oil Co. ---- 25
Sperry Sun Well Surveying Co. ---- 72
Standard Oil Co. (N. J.) ---- 28
Standard Vacuum Oil Co. ---- 16
Stevens Asbestos Products Company ---- 74
Stratford Engineering Co. ---- 6
Texaco Development Corp. ---- 5
Tube Turns, Inc. ---- 1
Universal Oil Products Co. ---- 63
Van Der Horst Corp. of America ---- 2
Watson-Stillman Co. ---- 77
Westinghouse Electric International Co. ----Inside Front Cover
Wyatt Metal & Boiler Works ----Back Cover
Youngstown Sheet & Tube Co. ----Facing Page 9
John Zink Co. ---- 79